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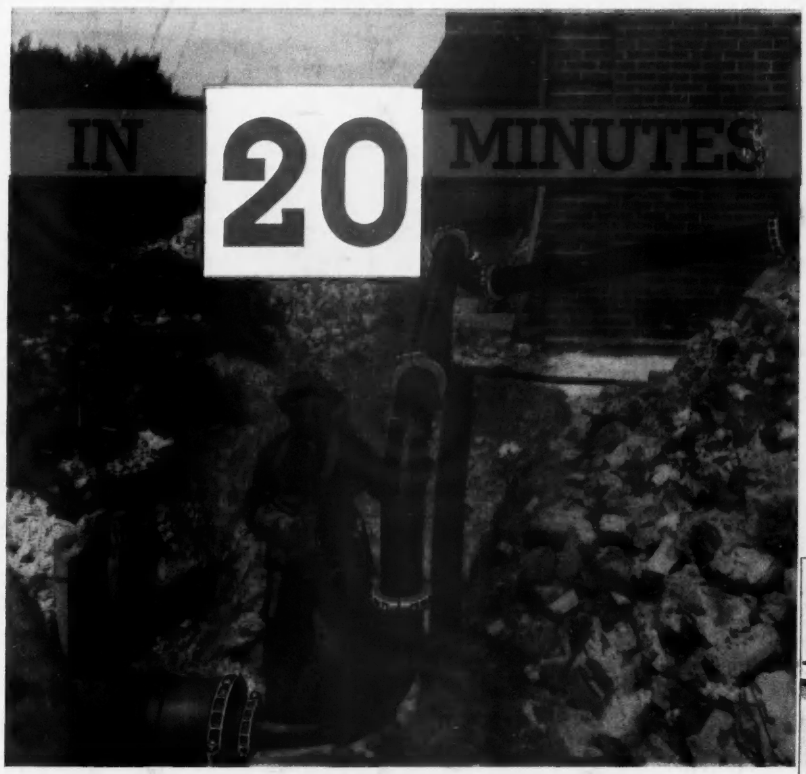
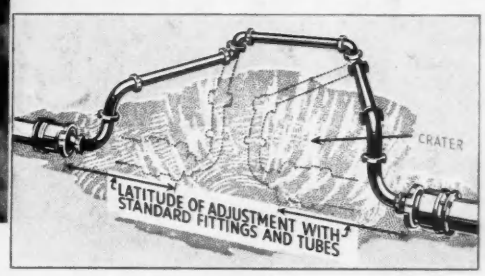


Below: Showing the Victaulic arrangement by-passing the crater; widely varying craters can be bridged by simply swivelling Victaulic fittings in their joints.



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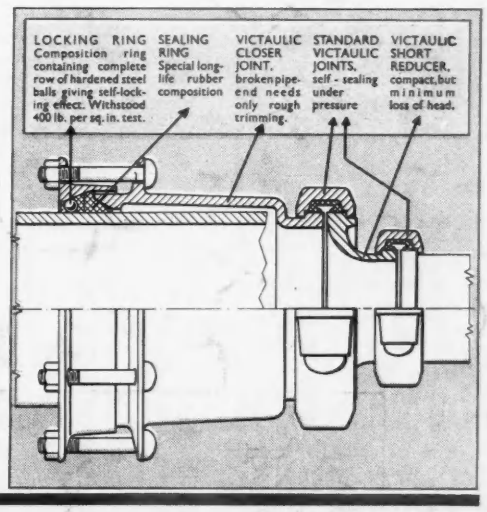
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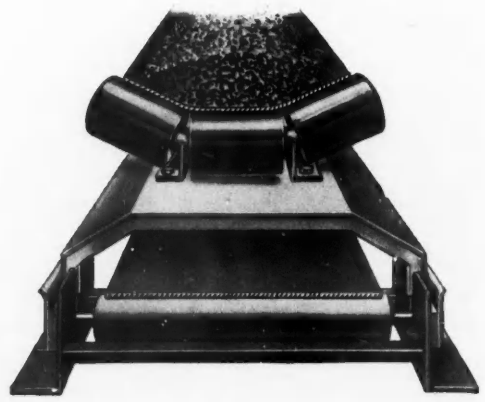

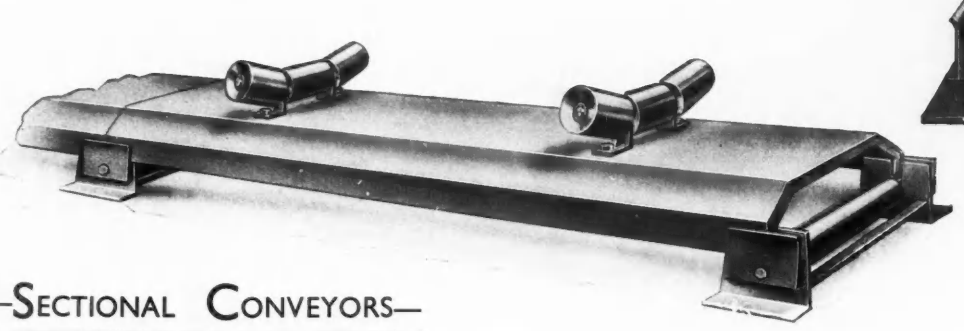

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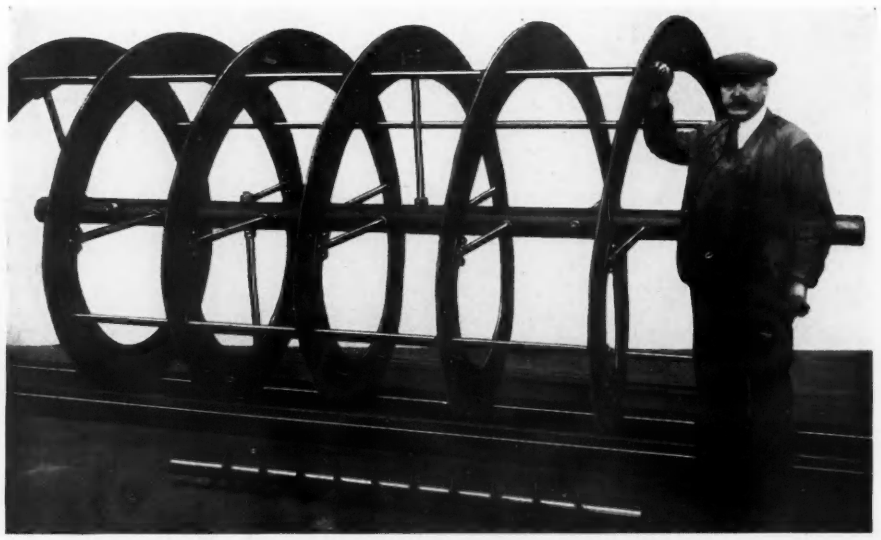

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A Seven-Day Journal

Engine Drivers' Wages

In one of last week's Journal notes we summarised the proposals of the Railway Staff National Tribunal, with regard to railway wages. On Thursday, October 26th, it was announced that on Wednesday, at a meeting of the Associated Society of Locomotive Engineers and Firemen, it was decided to accept the findings of the Tribunal on the subject of wages and other improved conditions of employment. In the opinion of the Union, although the Tribunal's decision does not give adequate satisfaction, the executive committee recognises that in many ways circumstances have changed, and for that reason it has been decided to accept the findings. It states, however, that the future interests of the members of the Society will be watched in the light of circumstances and the policy will be determined by them. According to the findings of the Tribunal, the wages paid to engine drivers will be increased from 12s. to 13s. per day during the first two years of service, and will remain at the same figure during the next two years. The rate of pay for Sunday duty has also been increased. While the wages of firemen and cleaners are not changed by the Tribunal's findings some of the cleaners who are twenty-one years of age will benefit by the raising of the general minimum wage in the industry. As yet no statement has been made by the other two railway unions involved, but we are given to understand that a delegate meeting of the National Union of Railwaymen has been called for Friday, November 3rd, at which the findings of the Tribunal are to be discussed.

The Auxiliary Military Pioneer Corps

On Thursday, October 26th, it was officially made known by the War Office that a new corps had been formed, to be styled the Auxiliary Military Pioneer Corps, recruiting for which began on Thursday, October 26th. Entry will be confined to men between the ages of thirty-five and fifty. Thus the new corps will open its ranks to the older man whose desire to serve can now to some extent be satisfied. The main object for which the new corps has been formed is to carry out work in connection with the maintenance of proper supplies of all kinds to our armies both at home and abroad. That object, it is stated, entails the handling at docks, bases, and depôts of a vast amount of stores, and the maintenance in fit condition, not only of the stores, but also of the roads and the railways forming lines of communication. In addition to these tasks it is quite possible that new roads may require to be constructed and light railways laid. The importance of these duties will be realised by men eligible to join the corps, and the hope is expressed that they will come forward and offer their services. The rates of pay and conditions will be the same as for British Infantry, and full details can be obtained at the recruiting offices. It is pointed out that men who are at present engaged in reserved occupations should not apply. Should there be any doubt with regard to this matter, advice should be sought at the nearest Labour Exchange.

London Passenger Transport Board

The sixth annual report of the London Passenger Transport Board, covering the year ended June 30th, 1939, shows that the year was an unfortunate one for the Board. The rate of growth of traffic continued to decline, whilst the expenses incurred in operation continued to increase. The sum received from the Pool was appreciably less than in the previous year, and as a result it was only possible to pay 1½ per cent. interest on the London Transport "C" stock compared with 4 per cent. in the previous year. The total number of passengers carried on the Board's system was 3,872,000,000 or an increase of 58,000,000 compared with last year. Adding the number of passengers which were carried on the suburban lines of the Main Line railways, the total number of passengers carried within the London Transport Area was 4,369,000,000, an increase of 51,000,000 compared with the previous year. The average number of rides per head of the population served was 444, which compares with 441 last year. The traffic receipts of the Board, after the operation of the Pooling Scheme, for 1938–1939, amounted to £31,069,753, an increase of £145,925. The average receipt per passenger journey for all passengers covered by the Pooling Scheme was 2·332d. or 0·009d. less than in the previous year. The number of car miles run by the Board's vehicles, in the service of its passengers, amounted to 573,000,000, an increase of 6,000,000 compared with 1937–1938. Roundly half of these increased miles were operated by trolley buses, consequent upon the closer services which are maintained by trolley buses, as compared with trams. The trolley bus, the Report states, has proved a popular vehicle, and the closer service has been fully justified. The Board's working expenses, excluding provision for renewal, amounted to £25,140,000, an increase of £216,907 as compared with the previous year. The total payments in respect of staff amounted to £17,629,038 or over 70 per cent. of the total working expenses, while the rates and taxes (not including income tax), licensed vehicle duty, licensing fees, and duty on petrol, and other fuel, amounted to £2,947,898, or 11·7 per cent. of the total working expenses. The charge by way of provision for renewal was £2,570,000, and the capital expenditure during the year on improvements and additions to the Board's undertaking amounted to £10,761,306. Further capital expenditure is under review with the Ministry of Transport, in the light of the changed circumstances arising from the outbreak of war.

Progress of Underground Railway Work

The Report of the London Passenger Transport Board for the year 1938–1939, states, in addition, that substantial progress has been made during the year towards the completion of the New Works Programme, 1935–40. The widening of the line between Harrow and Rickmansworth may have to be postponed, but satisfactory progress is being made with the lengthening of all platforms on the Bakerloo line, to accommodate longer trains. On the Central line, a large part of the extension both on the east and on the west, will be ready for use in the summer of 1940. On the eastern extension, between Liverpool Street and Newbury Park 15 miles of single line tunnel have been completed out of a total of 19½ miles. On the western extension the Great Western Railway is proceeding with the construction of the new lines between North Acton and Ruislip, and it is hoped to extend the Central line trains to Ruislip in the summer of 1940. The lengthening of existing platforms of the Central line will be completed almost immediately. On the Northern line the extension from Highgate to East Finchley was opened on July 3rd, 1939. The new station building at East Finchley will be completed by the end of 1939 and the new station at Highgate by the spring of 1940. It is hoped to make quickly some extension of service beyond East Finchley. With regard to trolley buses, thirty-nine miles of tramway have been converted to trolley bus operation during the year and altogether 191 miles of tramway have now been converted to trolley bus operation. Work is now proceeding on the new Metropolitan line station at King's Cross and the reconstruction of Sloane Square Station which will be completed in 1940. It is hoped with only small delay to complete those works in the programme which are substantially on the way to completion, or are essential to the convenience and safety of the existing works, but works upon which either little or no work has been done will necessarily be suspended during the war to release labour, plant and material for other work of national importance.

Central Electricity Board

The Central Electricity Board announces that Mr. Robert Blackmore, M.I.E.E., who has been the District Manager for North-West England and North Wales since the adoption of the scheme for the area in 1928, has tendered his resignation owing to ill-health. For the same reason Mr. S. E. Fedden, M. Inst. C.E., M.I. Mech. E., M.I.E.E., has found it necessary to relinquish his position as the District Manager for Mid-East England which he has held since the inception of the Scheme early in 1929. These resignations take effect on December 31st next, and Mr. C. T. S. Arnett, M.I.E.E., has been appointed to succeed Mr. Blackmore and Mr. V. A. Pask, M.I.E.E., M.I. Mech. E., City Electrical Engineer, Norwich, to succeed Mr. Fedden. Mr. Arnett, who has been the Board's Operation Engineer for North-West England and North Wales since early in 1931, served his apprenticeship at the Heaton Works of C. A. Parsons and Co., Ltd., and underwent his technical training at Armstrong College, Newcastle-on-Tyne, under Dr. Thornton and Professor Weighton. He afterwards joined the Cleveland and Durham Power Company (now the North-Eastern Electric Supply Company) under which company he held various appointments on the operating staff. Subsequently he became chief assistant electrical engineer on the staff of Bolckow Vaughan and Co., Ltd., and later held the position of chief electrical engineer of the Company's mines and iron and steel works. Prior to his appointment with the Central Electricity Board he was Chief Engineer to Pease and Partners, Ltd., of Darlington. Mr. Pask, who was born in Manchester, was educated in Preston, and received his engineering training at the Preston Technical Schools and in the Tramway Department of the Preston Corporation. He subsequently served on the staffs of the Paisley, Hull and Bootle Municipal Electricity undertakings and in 1920 was appointed Deputy General Manager and Engineer of the Newcastle and District Electric Lighting Co., Ltd., a position which he held for twelve years. In July, 1932, he succeeded the late Mr. F. M. Long as City Electrical Engineer of Norwich. Mr. Pask has served on the Central Board's Consultative Committee for the South-East England Area and has also been Chairman of the Generation Committee of the Incorporated Municipal Electrical Association for the same area. He is a Municipal member of the National Joint Board and the National Joint Industrial Council for the Electricity Supply Industry and serves on the Employers' Side of the Council's Negotiating Committee, being also a Municipal member of the District Board and District Council for the No. 8 (East Coast) Area.

Licensing of Machinery Imports

On Monday, October 23rd, the Board of Trade issued an Order prohibiting the import except under licence of machinery and plant. The Order came into force on Wednesday, October 25th, but goods of the kinds affected which were despatched to the United Kingdom before that date will not be subject to the Order. A notice containing a list of the machinery, etc., covered by the Order and giving instructions as to the way in which applications for import licences should be made can be obtained from the Import Licensing Department (Machinery Licences Division) of the Board of Trade at 25, Southampton Buildings, London, W.C.2. In making this announcement the Board of Trade desires to explain that there will be no reduction of expenditure on imports of machinery as a class and indeed that requirements for the purpose of war-time industrial production are likely to result in a substantial increase of imports of machinery. It is, however, essential to ensure that these imports are as far as possible of kinds which are necessary to our war effort and are also not of kinds procurable from United Kingdom manufacturers of machinery. For these reasons the present Order has been issued to provide the desired measure of import control of any imports failing to satisfy these conditions; where the conditions are satisfied, however, import licences will be issued freely and without delay. It is also pointed out that the control of machine tools is governed by the Control of Machine Tools (No. 1) Order, 1939, and import licences for machine tools will be issued only to importers approved by the Controller of Machine Tools. Applications should be made in the first instance to the Controller of Machine Tools, Portland House, 14, Tothill Street, S.W.1, for inclusion in the list of approved importers. A list of items deemed to be machine tools for the purpose of import licensing may be obtained from the Controller of Machine Tools. In cases where an import licence has been granted, the Treasury wishes it to be known that it is prepared to consider, under Section 10 of the Finance Act, 1932, applications for duty-free licences in respect of consignments of machinery falling within approved classes. A list of these classes is contained in Notice T.N.1 which together with the necessary application forms can be obtained from the Import Licensing Department, Machinery Licences Division, or in the case of machine tools, from the Controller of Machine Tools.

The Empire's Output of Minerals

The latest compilation of figures of the world mineral production, showing the proportionate share of British Empire countries, is given in the most recent issue of the Bulletin of the Imperial Institute, South Kensington. Comparison between the outputs of 1935 and those of 1937, the latest year for which complete data are available, shows that although both the world and British Empire outputs of the most important and many secondary minerals were in every instance considerably greater in 1937 than in 1935, the percentages contributed by the Empire remained fairly constant, except in mica, chrome ore, manganese ore, and asbestos, which showed large increases in 1937. There were also increases in the percentages of petroleum, tin ore, silver, potash salts, phosphates, nickel ore, pyrites, and bauxite, but decreases in coal, gold, zinc ore, iron ore, copper ore, lead ore, salt, sulphur, and diamonds. Of the total value of the British Empire mineral output in 1937, the United Kingdom accounted for two-fifths, and the Dominions, India, and Burma for nearly half the total amount. The African Colonies contributed 4·40 per cent., the Asiatic Colonial Empire 4·48 per cent., and the territories mandated either to the United Kingdom or to the Dominions accounted for only 0·61 per cent. of the production. The output of coal in the British Empire was just over 40 per cent. of the total value of the mineral production. Gold accounted for 26 per cent., and other chief items were:—Copper ores, 5 per cent.; tin ore, 4½ per cent.; silver-lead-zinc ores, 4 per cent.; nickel ore, nearly 2½ per cent.; iron, manganese, and chrome ores, 2 per cent.; petroleum, 2 per cent. Coal output in the British Empire keeps very constant at about 300,000,000 tons. More than three-fourths of this quantity is produced in the United Kingdom, and 90 per cent. of the balance in India, the Union of South Africa, Canada, and Australia.

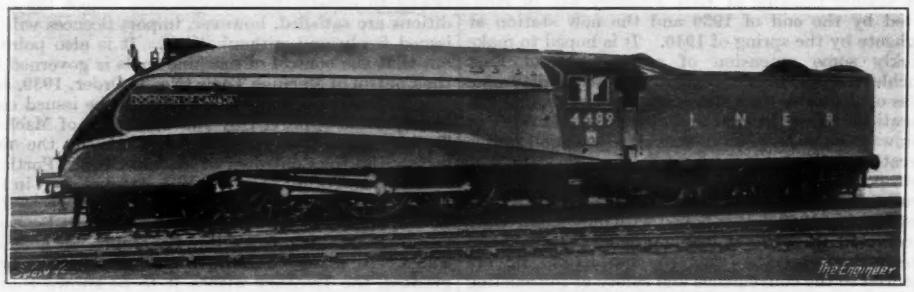
Scottish Locomotive Experiences

By E. H. LIVESAY

No. VII.—L.N.E.R. EDINBURGH–NEWCASTLE TRAINS. "A 4" ENGINES

(*Continued from page 416, Oct. 27th*)

FOR many reasons my Scottish locomotive experiences were very interesting, and, in nothing more so than their divergence. No two were quite alike. There were striking variations in the engines, loads, gradients, and timing; even the scenery showed distinction, except perhaps so far as the Northern runs to Mallaig and Inverness were concerned. Where two runs showed some degree of similarity in one respect, there was sure to be contrast in another, and this comes out in the following account of a couple of runs over the Edinburgh–Newcastle line, with an "A 4" class engine. Though that class has already been dealt with before, in "The Flying Scotsman" article (THE ENGINEER, March 31st), and to a limited extent in the last one, it is such an outstanding design that it will easily bear more being said about it, especially as in the two runs to be described the engine was employed on contrasting duties, light and heavy, and over a route quite different in contour to the others coming into the Scottish series. These have been concerned with the two gradient extremes, the Edinburgh–Glasgow line being exceptionally easy, and all the other Scottish routes I travelled over, very hard. The Edinburgh–Newcastle stretch is neither one thing nor the other; it comes betwixt and between, and is suitable for high average speeds, which was not the case with most of the other routes. To sum up, if the reader detects a trace of repetition, he should bear in mind how very difficult it is to keep it out, and if he will look at the whole of these articles, instead of at only a part, I hope he will find that in spite of it, "age doth not wither nor custom stale the infinite variety" of these my Scottish locomotive experiences.



L.N.E.R. A4 CLASS ENGINE "DOMINION OF CANADA"

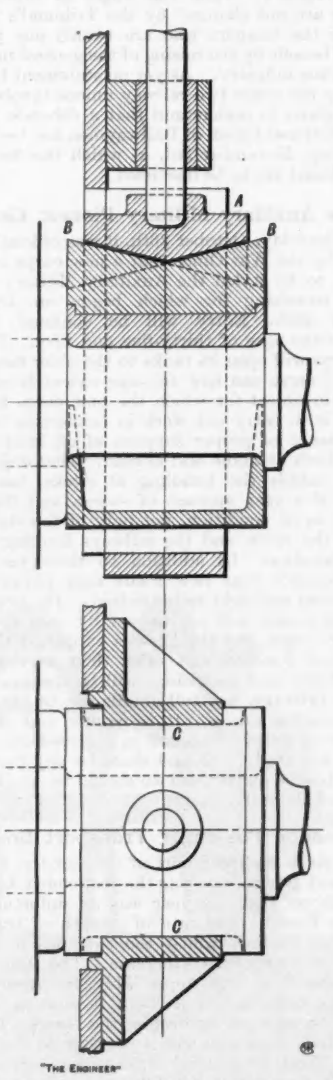
I must first spike the guns of the pedants, by admitting that the Edinburgh–Newcastle line extends well over the border into England, so if they are very punctilious, I advise them to cease reading when the train reaches Berwick. I am really helpless in the matter. I am obliged to take the story on to Newcastle because that is where the engine took me. No. 4488, "Union of S. Africa," and I were as inseparable as Mary and her little lamb; everywhere the engine went, this scribe was sure to go. After all, Scottish history was only repeating itself; the Blue Bonnets were always crossing the border, returning with booty of one kind or another, so it is only in keeping with tradition that the blue "Pacific" should make a raid into England, to bring back something of benefit for these Scottish "Experiences."

Leaving Waverley Station, Edinburgh, for the South, there is an immediate drop of 1 mile at 1 in 78, after which there is nothing worse than 1 in 200 for 35 miles. Then the north side of the Cockburnspath bank exhibits 4 miles of 1 in 96, and on the south side there are 17·5 miles, mostly descending, into Berwick, the last 4·5 miles being at 1 in 190, after which there is nothing to cause concern until the Criston Bank, from Falloden, 23 miles farther on, is reached. Here the gradient stiffens for 2·5 miles, at 1 in 150 up. Continuing, 4 miles of 1 in 170 down are found, and thence, frequently fluctuating insignificance describes the ensuing 35 miles into Newcastle, which is 124½ miles from Edinburgh.

Returning northbound, the route gave me the impression of being somewhat harder. From Goswick, through Berwick, for instance, there are 23 miles of intermittent climbing to just beyond Grant's House; into Waverley Station, the 1 in 78 pitch mentioned before has to be taken. Curvature is rife, especially along the coast stretch north of Berwick. Notwithstanding, this piece of main line, though far from easy, cannot be called exceptionally hard, and it bears no comparison with the Highland and Aberdeen routes. So much for the venue; it only remains to say a few words more about the engine before describing the work it did. There is no need to give the dimensions, as they were set out in "The Flying Scotsman" article (THE ENGINEER, March 31st), and in that dealing with the "V 2's," the boiler and firebox being much the same in the two classes, except that the "A 4's" combustion-chamber and tube-length are each increased by 1ft. The valve-gear is also similar, but the travel is 5¾in. on the "A 4's," and 5⅝in. on the "V 2's," the maximum cut-off being 65 per cent. The heating-surface is 3325 sq. ft., the superheater providing 749 sq. ft. of this. The factor of adhesion is 4·18.

The two runs to be dealt with were made on engine No. 4488, "Union of S. Africa," a replica of "Dominion of Canada." Incidentally, the bell and whistle carried by this engine were given by the C.P.R. The former is entirely ornamental. The train was the 10.15 a.m. ex-Edinburgh, made up of only five coaches, a dimunitive load of less than 175 tons gross. Presumably, giving an "A 4" such a trivial task was partly due to the engine being wanted at Newcastle to bring the "Flying Scotsman" on to Edinburgh in the afternoon. Driver Waugh and Fireman Brand were in charge, and we left punctually, a glorious spring morning, making the run stand out from most of my Scottish trips. As there is a descent at 1 in 78 almost at once, and with what one can almost call no load at all, acceleration was naturally rapid, a speed of 60 m.p.h. would have been reached before Portobello, 3 miles from the start, but for a 40 m.p.h. speed-restriction at that point. "No. 4488" obviously did not realise she had anything whatever behind her, and this happy state of things was reflected in the fireman's labours; they were almost as non-existent as the load. The firedoor was kept wide open, cut-off was 15 per cent., and the regulator was seldom more than half open. I decided that there was really no need to keep a detailed record with such a train, particularly as the engine would be coming back on the "Flying Scotsman," with the Flaman recorder in action, when very full particulars could be taken. I, therefore, contented myself with absorbing general impressions, beginning with how the engine reacted to internal and external disturbances. Apparently these were not serious, as the riding was good, with little of the tendency to tailwagging I have sometimes noticed on "A 4's." Prestonpans, 9½ miles, was passed at 10.27 a.m., Brand pointing out the site of the battle in which Bonnie Prince Charlie distinguished himself, and extinguished Sir John Cope, 1745. I knew he would—I was ready for it. Fireman Kinnear did the same thing on the "Flying Scotsman"; the enginemen never overlooked anything redounding to Prince Charlie's credit, and I have learnt more about him during these trips than I ever dreamed of before. There are no gradients along this stretch likely to have the slightest effect on "No. 4488," with her paltry load, the train jogging along at 65–70 m.p.h., with nothing to disturb the even tenor of its way, giving me a fine opportunity to enjoy the views of the Forth and the Coast to our left. Dunbar, 29 miles from Waverley, was passed at 10.45 a.m., an average of 58 m.p.h., and the gradient began the preliminary rise towards the heavy Cockburnspath bank of 1 in 96. This was taken at roughly 50 m.p.h., evidently a speed far below what could have been reached, but as we were already well ahead of working time, there was no necessity for anything faster. The short Penmanshiel Tunnel is on this bank, and a mile beyond the southern portal, the highest point on the North British section of the main line is reached, after which the ruling gradient is downward, over the Border—passed at 11.14 a.m.—into Berwick, where the train came to a stand at 11.17 a.m., 3 min. ahead of time; 57·5 miles in 62 min., 56·3 m.p.h.

Leaving again at 11.22 a.m., running at once on to the 28-arch Royal Border Bridge over the Tweed, a monument to Robert Stephenson, "No. 4488" resumed her 65 m.p.h. amble, but under the circumstances—trivial load, perfect weather, and easy timing—it was difficult to find much to note down, so I turned my attention from details to things generic, such as the cab and its fittings; the Flaman recorder; the riding, which



PRINCIPLE OF CARTAZZI TRUCK

always interests me, and so on. As I have said, this was good, though it fell below that of the wonderful 2–6–2, "No. 4793." That was an engine to conjure with! It seems unlikely that the action of a 2–6–2, could be better than that of a 4–6–2, yet in that never-to-be-forgotten instance, it was so. But it confirmed my theories about the "Cartazzi" truck, which naturally gives me a feeling of satisfaction! On this Newcastle run, with only occasional note-taking to interfere, I gave a good deal of consideration to just how the truck was behaving, and was likely to. There are no control-springs on the "Cartazzi," to bring the axle back to centre, only short inclined planes on the axle-box top, which incidentally take the load as well. It seems that ridges might be likely to develop towards the outside of the planes, on which the sliding spring-carrying block would tend to stick momentarily, but if the side pressure due to a curve in the track increased sufficiently to overcome this adhesion,

the ridge would "give" suddenly, causing a quick lurch, and possibly producing an exaggeration of the side-sway that would normally have accrued. This action is exactly what I have noticed—a sudden kick sideways of the footplate, followed by a somewhat irritable return to centre, quite unlike what one would expect to get from the gradually increasing or decreasing control of a spring.

With regard to the curved guides on the main-frames, much the same defect, the formation of ridges—I should imagine chiefly on the rear side of the axle-box, the trailing edge—would seem likely to show up. If the "sticking points" should happen to form in such position as to come into action on top and side surfaces simultaneously, the resulting jerk would be intensified. When this apparatus is in good shape, as it certainly was on "No. 4793," it undoubtedly works well; it is when wear develops that its action may leave something to be desired.

The sketch herewith shows the principle of the "Cartazzi" truck, and the lines on which it is constructed. The load is transferred to the axle-box by the spring pillar, which takes a bearing in the sliding block A, this in turn being forced up the inclined planes B by side pressure due to track curvature, returning to centre when the straight is re-entered. This sketch does not represent the L.N.E.R. truck, merely illustrating the principles. The "Pacifics" have curved guides, whereas the sketch shows the straight type C, which only produces transverse movement of wheels and axle. It indicates where it would seem "high spots" are likely to develop, on axle-box top and guides.

Is not this an example of the benefit of learning from the experience of others? The single trailing truck has been used on American engines for a longer period and to a much greater extent than over here, often running over far less perfect track; the curved guide system is never used, but always the forward-reaching yoke to a central anchor-pin, such as is found on the L.M.S. "Coronations." "The proof of the pudding is in the eating thereof"; that method of construction always has worked well in America, and still does, on thousands of engines, so it is obviously safe to copy it. It is used with 4-wheel trucks, too, and works equally satisfactorily then. In England, there is only one express engine with four wheels under the cab, the L.N.E.R. "No. 10,000," but in this case the two axles are independent of each other, the one "Cartazzi" controlled, and the other—I do not know how! I have had no experience of this engine, so anything said about it is purely theoretical, but I should not imagine the action likely to be really good. It appears to be a "Pacific" chassis adapted to take a larger firebox, by adding another carrying axle, and adaptations are seldom as satisfactory as a basic design.

Meanwhile, "No. 4488" was still speeding towards Newcastle, though I admit I was not taking many notes of its performance. Cab-comfort came up in the course of the run, in conversation with Brand; he was as pleased with it as were all the L.N.E.R. men I consulted on the subject, but as I dealt with this thoroughly in the last article, there is no need to refer to it again here, except to say that I was told that some years ago, Sir Nigel Gresley had a full size wooden model of a cab made, with the usual fittings in place, in order that critics might register approval or the reverse, and suggest improvements. An admirable thing to do, well worthy of imitation, which could only be productive of good. The present cab might well serve as a model of what a cab should be.

To get back to the run; Lucker troughs transferred my wandering attention from theory to practice, which in turn prompted me to compliment Brand on the fact that he was wearing gloves! I think it is quite in order; it is the invariable rule in Canada and the States for enginemen, but I have only come across one other man during my British runs who had adopted this protective habit. This was Fireman Smith, on the Plymouth–London "Castle" (THE ENGINEER, April 14th). I remember asking him what the idea was, and his reply: "Well, I don't see why a fireman should have rough hands, all over corns!" I quite agree—why should he? Which reminds me that I shall probably develop corns, too, though not on my hands, if I have to sit on wooden seats much more. Gloves will not save me, but a cushion would; running departments, please note.

Passing Killingworth, I saw a little ivy-covered cottage close to the track, where George Stephenson once lived. He was born at Wylam, in a house also close to the lineside, a plaque attesting to this. We were nearing Newcastle, running through a maze of junctions, curves, and over a gridiron of switches and crossings. The great Byker Viaduct crossed, the train came to a stand in Central Station at 12.32 p.m., 3 min. early, having covered the 124½ miles from Edinburgh in 137 min., with one stop, at an average speed of 54·5 m.p.h. inclusive.

The 2-hour "turn-around" at Newcastle gave me time to look into the working of the Flaman recorder, so perhaps I may say a little about it, as it is such an interesting fitting.

The L.N.E.R. has adopted speed indicators and recorders to a greater extent than any other British Company, the introduction of unusually fast trains, such as the "Silver Jubilee" and "Coronation," being responsible for this. All engines of the "A 4" class are fitted with these instruments, and as I have referred to them many times in these articles, the rather colourless character of the run I have described, due to the light load, provides a good opportunity to describe the Flaman machine, to which I had given a good deal of attention en route, in the absence of more important distractions. This instrument shows by a hand the speed at which the engine is travelling, and makes a permanent record on a paper strip of the speed, time taken, and distance travelled. There are two hands, red and black, on the semi-circular face forming the upper half of the case, the black one moving over the speed scale—marked up to 126 m.p.h.—the red one remaining stationary at any predetermined figure to which it may be set, such as a speed restriction, or the highest permitted rate of travel. It is set at this figure by a small handle outside the case. Therefore, there is no need to watch the position of the black hand on the scale to see whether this allowed figure has been reached or exceeded, the coincidence of the two hands showing it at once.

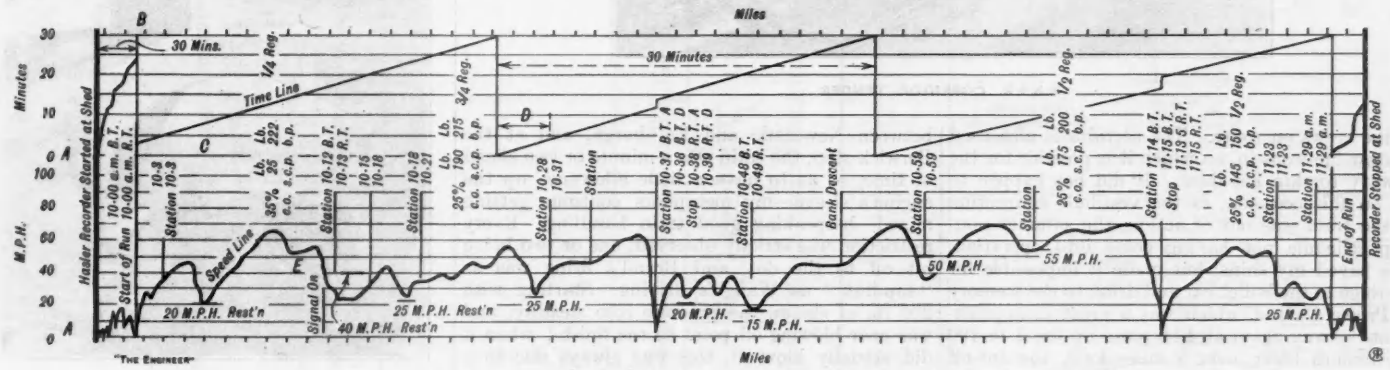
As the instrument is worked from the driving-wheels—the right-hand rear coupling-rod pin in this case—the figures recorded can be inaccurate, where there is tyre-wear, and if absolute accuracy is called for, allowance must be made for this, should it exist. I presume that slipping can upset it too; this will, of course, also be recorded on the paper if it is sufficiently serious.

In order that the reader may see what a record looks like, I have made an approximate copy of one, bringing out the chief points; an actual recording would not reproduce clearly. The exact locality of the run is immaterial; I content myself with admitting it is somewhere in Scotland.

It is from a Hasler Teloc, but there is so little difference between the records of Hasler and Flaman instruments that it will serve for both. The upper part of the paper strip deals with Time; the lower, Speed. The machine was started at the Shed, the two needles recording Time and Speed beginning to move at A′ and A respectively. Shed and station-work are shown by the numerous minor moves at the beginning. The Time needle moves diagonally when the engine is running, but vertically when it is stationary, and also drops vertically to the zero line every 30 min. It will be noticed that it had dropped 4 min. before the train started at 10 a.m., as the oblique movement begins a little below the 5-min. horizontal line. This accounts for the misleading—until the above fact is grasped—considerable lack of coincidence of the second "drop" with the passing of a station at 10.31, "D," though the train had started at 10 a.m. The vertical movement of the Time needle shows up at the two intermediate station stops. This graph brings out the incessant fluctuations of speed on some of the Scottish routes, due to curvature, gradients, and the numerous speed restrictions. It will be seen that 70 m.p.h. was reached several times; the very sudden drop in speed before an adverse signal is indicated at "E." "B.T." means "Booked Time," "R.T." "Running (actual) Time," from which it comes out that time was slightly lost at first, then regained, the finish being a little ahead.

I gathered that some drivers are not exactly in love with the Recorders, and would like to throw mud at the accuracy of the stories they tell. This shows a very human reaction, but I fear the critics are playing a losing game! It is not nice to have our sins of omission and commission put down in black and white, and because these tell-tale machines do this, their occasional unpopularity is quite understandable.

It should be mentioned that many other details are put down subsequently on the actual recording,

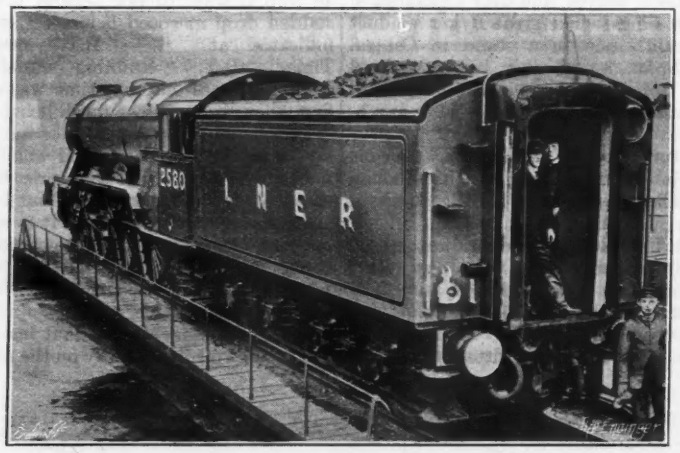


TYPICAL "HASLER TELOC" RECORD OF A RUN

such as boiler and steam-chest pressure, cut-off, regulator position, etc., as noted at different points, making the story of a run very interesting to study afterwards. I have included only a few. Of course, this gives the human element a chance to intrude, and for errors to creep in. I have come across several minor ones on the recordings of my runs, but to err is human, and I would ask the reader to bear this unpleasant fact in mind before he picks holes in my pen-and-ink diagram. It is *approximately* right! Towards the finish of this run, it will be seen that the boiler-pressure was down to 150 lb., as the fire had been allowed to die down, in preparation for the stop, and the passage of the engine to the shed.

The return journey to Edinburgh promised to be far more interesting than the other, as it was with "The Flying Scotsman," which only runs non-stop from London during the summer months. The engine and crew were the same as in the morning, but the load was 450 tons gross, and the start was made punctually at 2.45 p.m. The immediate gradient out of Newcastle is downward, but half a mile outside, at Manors East, a climb of 1 in 240–208 begins, with a 45 m.p.h. restriction, and here the cut-off was 30 per cent. The pressure was down to 200 lb. at the start, but in spite of the climb and three-quarter open regulator, it rose to 250 lb., and blew off—purposely, I was told, to prove that the safety-valves were ready to do what they should. Brand was a first-class man; the firing up, though heavy, produced no excessive smoke. Over incessantly varying gradients, though none were severe, the speed rose steadily to 65 m.p.h., the cut-off being 18 per cent. and regulator three-quarters, until it was brought back for a 40 m.p.h. restriction through Morpeth, 17 miles, 22 min., 2 min. ahead of time. It soon rose again to 60 m.p.h., remaining close to that figure for 16 miles to Alnmouth. On the suc-

ceeding 4 miles 1 in 170 climb to Little Mill, it fell to 45 m.p.h., the cut-off still being 18 per cent., s.c.p. 220 lb., b.p. 240 lb., ¾ regulator; once over the peak it rose to 68 at Falloden, and at Lucker troughs water was picked up at 55 m.p.h. Belford, a mile ahead, was run through at 3.57½, 3½ min. early. Three miles on, it had to come down to 20 m.p.h. for a permanent-way slowing, and the nearly shut regulator resulted in blowing-off. A steady increase of speed to 65 m.p.h. at Goswick followed, where the 3½ mile 1 in 230–190 climb to near Tweedmouth begins, on which it fell to 48 m.p.h. The Border Bridge, restricted to 40 m.p.h. having been passed, "The Flying Scotsman" came to a stand in Berwick at 4.10 p.m., 1 min. early; 67 miles in 76 min., average speed 53 m.p.h. In a previous article I referred to the corridor tender, shown herewith, a feature of the L.N.E.R. "Pacifics." It was adopted to enable the 392-mile non-stop London–Edinburgh runs to be made, as these necessitate the changing



L.N.E.R. CORRIDOR TENDER

of the crews en route. The corridor is also used to stow fire-irons in, on which it is possible for the unwary to skin his shins. It did not happen to me on this occasion, as the vestibule connection to the train was out of action, the summer non-stop schedule not having come into operation. This saved my shins, but made it impossible for me to go to the buffet-car and drink to the memory of Prince Charlie, which was a great disappointment. Away again at 4.16 p.m., up the 1 in 190 Burnmouth bank, over 4 miles long, the cut-off was 45 per cent., s.c.p. 220 lb., b.p. 235 lb., regulator ¾, and the speed reached 65 m.p.h. At a point 2 miles before Reston, a 1 in 200 upward gradient begins; here it began to fall, being 48 m.p.h. at Grant's House and so over the peak. Up this bank, the c.o. was 18 per cent., s.c.p. 190 lb., b.p. 240 lb., regulator ¾. On the descent through Cockburnspath, the speed reached 78 m.p.h., to show a reduction to 66 m.p.h. nearing Innerwick, where there is a 70 m.p.h. restriction. Seventy was then held for several miles, reduced to 60 m.p.h. through the Dunbar restriction. The succeeding 23 miles to Monktonhall were covered with a striking effortless regularity, the speed remaining very constant at between 53 and 60 m.p.h., until we slowed for a 40 m.p.h. restriction at Portobello, one of 35 m.p.h. following near Piershill. The final 1 in 78 pitch up into Waverley Station called for a cut-off of 30 per cent., s.c.p. 175 lb., b.p. 235 lb., and a regulator ½ to ¾ open. "The Flying Scotsman" came to a stop in Waverley Station, Edinburgh, at 5.18 p.m., 2 min. early; the 57 miles from Berwick had taken 62 minutes, or 55 m.p.h., and the 124½ miles from Newcastle, with one stop, 144 min., an average speed of 51·8 m.p.h.

The only striking thing about this run was its absolute perfection! Because of its impeccability, nothing stands out; I cannot imagine one more flawless. No very high speed was reached, 78 m.p.h. being the maximum, attained once, yet the schedule was adhered to with a meticulous exactitude that can be seen over the whole length of the Flaman recording. At every passing point between Newcastle and Edinburgh, and at the Berwick stop, the train was a minute or two ahead of time, so as to have a little allowance up the engine's sleeve—my metaphors continue getting mixed—bespeaking good train handling. Every restriction was strictly observed, one or two being hit off to the dot, and Brand's firing was as "top-link" as Waugh's driving. Starting with 200 lb. of steam, the pressure rose steadily, and was near blowing-off point to the finish; when it did actually blow-off, this was always due to a speed-restriction, or some such fly-in-the-ointment which Solomon with all his wisdom could not have off-set. It is hardly necessary to say that the crew showed me every courtesy and consideration; to such an extent that, on the return journey, Brand deliberately let Prestonpans go by without saying a word about Prince Charlie, though the temptation must have been terrible, as I was absolutely in his power. But so it has always been; I have had nothing but good relations with all the crews under whose care I have been placed. It is a fitting note on which to end this article.

(To be continued)

The Ladybower Reservoir

THERE is now under construction on the River Derwent in Derbyshire, a dam which will impound between five and six thousand million gallons of water. This sheet of water will be named the Ladybower Reservoir. By the courtesy of the Derwent Valley Water Board, and Mr. H. P. Hill, of the firm of G. H. Hill and Sons (Manchester), Chartered Civil Engineers of 51, Mosley Street, Manchester, the engineer responsible for the design and for the supervision of the construction of the works, we are now able to publish the accompanying drawings and to give some account of the work. The dam is being constructed by the contractor, Mr. Richard Baillie, of Haddington.

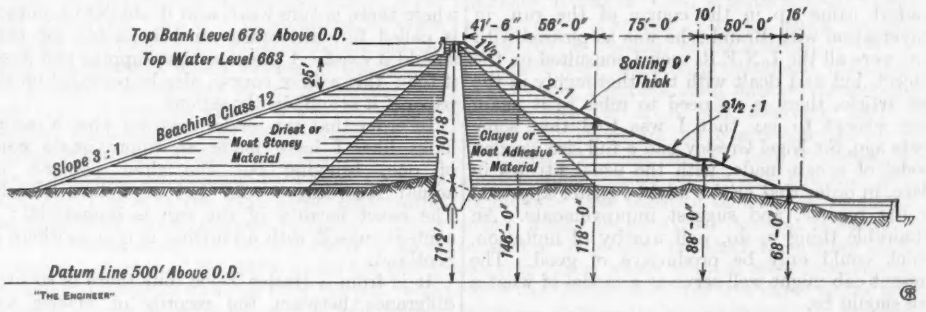
The Derwent Valley Water Board, the constituent members of which are the corporations of Leicester, Sheffield, Nottingham, and Derby, together with the County Council of Derbyshire, was created a public authority by Act of Parliament in 1899 and authorised to utilise for waterworks purposes the head waters of the Derbyshire Derwent, including those of its tributary, the River Ashop. A drainage area some 50 square miles in extent was put under the control of the Board, and it is estimated that when all the works envisaged have been completed the yield of the area, even in a very dry season, is likely to amount to 55 million gallons a day. Since its creation the Board has by degrees extended its works. In 1912 the Howden reservoir was completed, and four years later the Derwent reservoir was brought into use. As the work progressed and further experience of practical circumstances accrued, schemes originally proposed have been modified. There was, for instance, a project for creating reservoirs on the River Ashop. But that scheme was abandoned, as it was found that the function these reservoirs were intended to perform could equally well be undertaken by the Ladybower reservoir, which is now under construction and which will be given a capacity in accordance with the altered plans. In order, however, that the benefit to be gained by storing water from the Ashop should not be deferred until the Ladybower reservoir came into use, intake works were constructed and the waters of the stream were diverted through a tunnel into the Derwent reservoir, where they have proved useful for replenishment in times of drought.

The dam of the Ladybower reservoir consists of an earthwork embankment in the centre of which there will be a core of clay puddle, founded on the concrete with which the cut-off trench below it is refilled. The embankment, which is

TUNNELS UNDER CONSTRUCTION

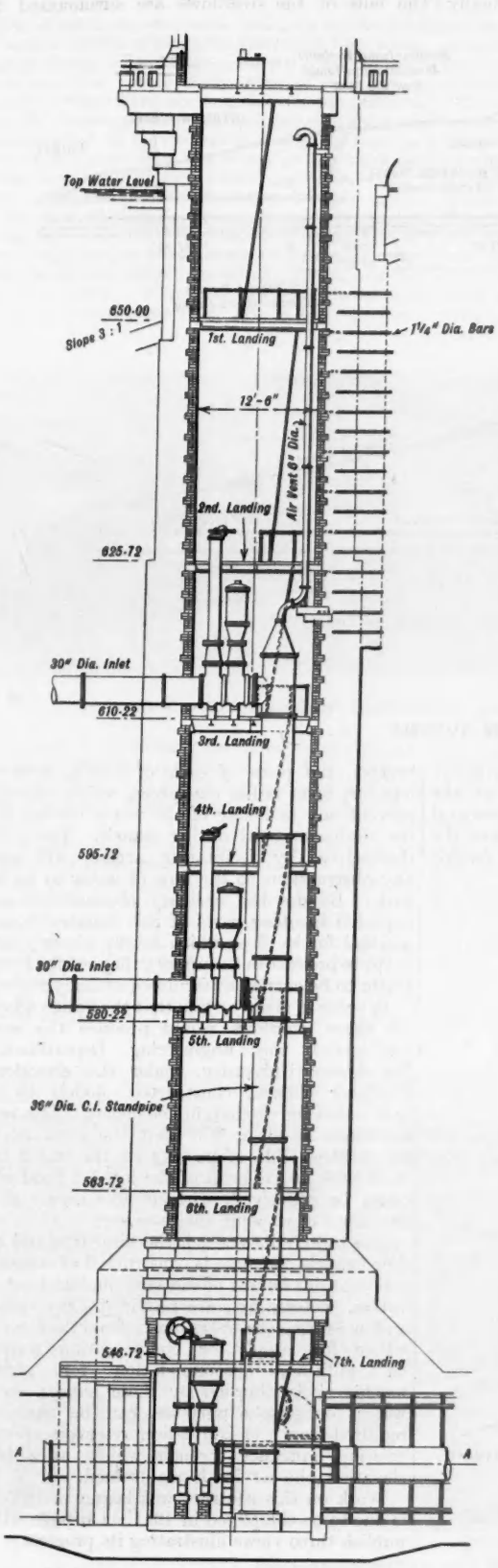
about 1250ft. in length, has a maximum height of rather more than 140ft. above the river bed and about 900,000 cubic yards of material will be used in its construction. On its upstream face, which will have a slope of about 1ft. vertical to 3ft. horizontal, the embankment will be protected by a covering of stone "beaching" on the lower and stone "pitching" on the upper part, all set on a foundation of broken stone resembling road metal, as shown by accompanying drawings. Where this stone pitching reaches the summit of the embankment it will form the foundation of the screen wall, which will extend throughout the whole length of the dam. The downstream slope, which varies between 1½ft. and 2½ft. horizontal to 1ft. vertical, with intervening "berms" at suitable intervals, will be covered with soil and grass, and along the top of the dam there will be formed an occupation road, 12 feet wide, for the purpose of affording private access across the valley.

Excavation of the central trench is finished. It has a width of 6ft., and although the average depth is about 170ft., a maximum depth of upwards

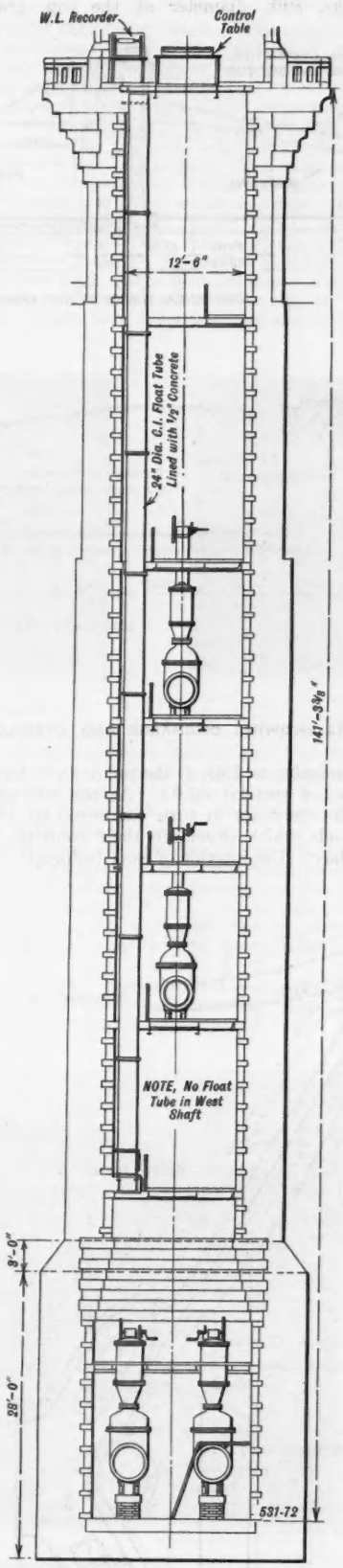


SECTION OF RESERVOIR DAM

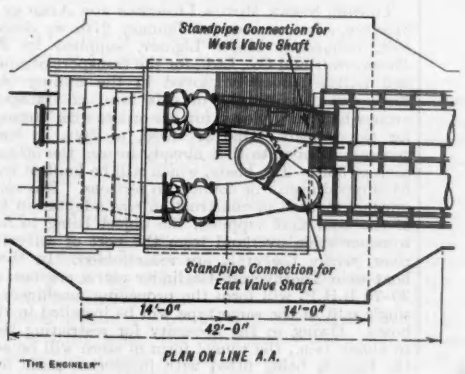
LADYBOWER RESERVOIR



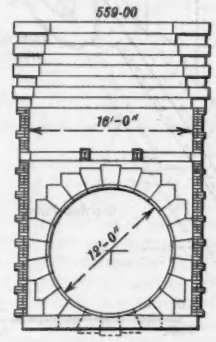
SECTIONAL ELEVATION ON C.L. OF EAST DISCHARGE TUNNEL.



SECTIONAL ELEVATION LOOKING UPSTREAM.



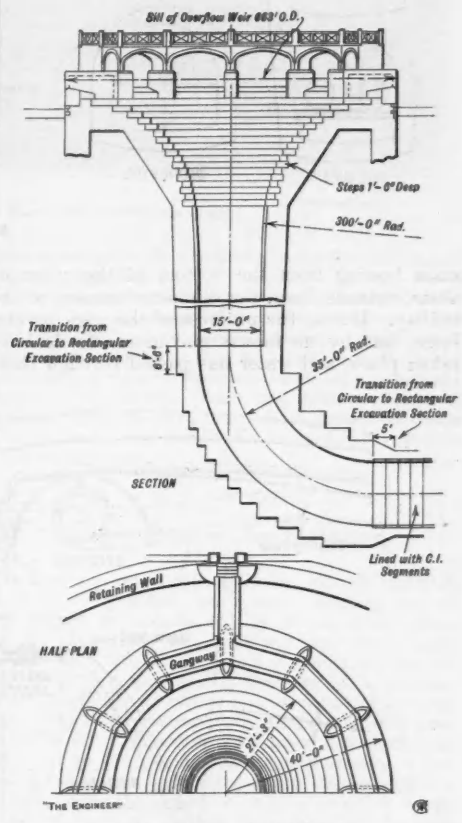
"THE ENGINEER" PLAN ON LINE A.A.



ELEVATION OF OUTER TUNNEL.

SECTION OF VALVE SHAFT

of 250ft. was reached at the eastern end. Refilling of the trench with concrete has been practically completed and work is now proceeding on the formation of the "spearhead" and the enlargements where the junction of the concrete cut-off wall with the clay puddle core occurs. In continuation of the central trench, headings have been driven, eastwards and westwards, into the hillside for a distance of upwards of 500ft. in each instance, from which boreholes have been and will be sunk for the purpose of injecting grout into the strata at either end of the dam. During the refilling of the central trench with concrete, mandrel holes of small diameter were formed at frequent intervals and were carried up as the work proceeded until eventually the surface was reached. These holes were provided for the purpose of enabling the contractor to sink bore-holes beneath the bottom of the concrete in the trench, through which grouting could take place, and at the present time the grouting of the strata is the principal operation in progress. The grouting at this reservoir will, of course, constitute a very important and major portion of the work, on account of the extent of the central trench, as well as the headings situated at either end thereof, and up to the moment, so the engineers inform us, results have indicated that what has already been done in this connection is



OVERFLOW BELLMOUTH

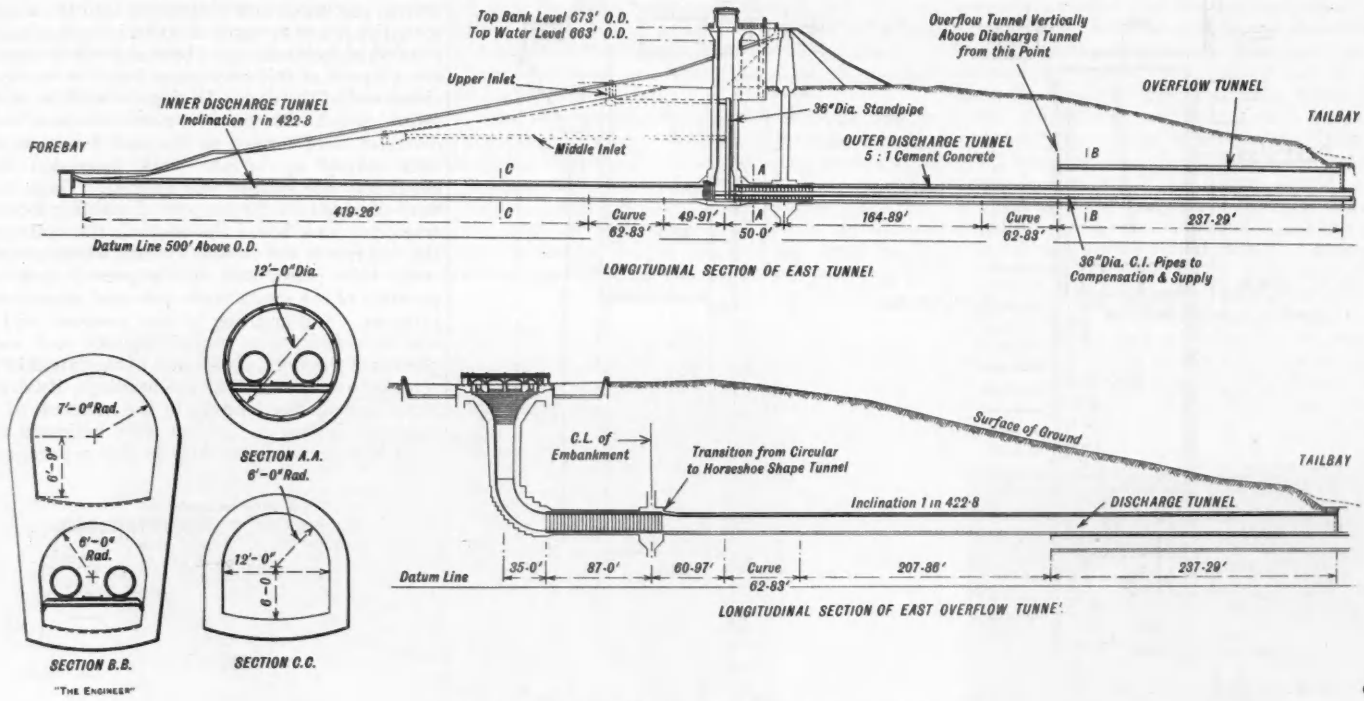
proving to be all that could be desired in achieving the necessary object. The formation of the embankment with earthwork is meanwhile proceeding, and the same remark applies also to any other operations, such as those in the tunnels, valve shafts, &c., which can continue without interfering with the progress of the grouting.

One of the first operations to be undertaken in a contract of this character is, of course, the construction, as quickly as possible, of the discharge tunnels, of which, in this instance, there are two, whereby the waters of the river can be diverted, in order to facilitate the excavation of the trench. The discharge tunnels at Ladybower are formed of concrete and are 12ft. wide and 12ft. high. Their positions are indicated in the drawings. The forebays connected with these discharge tunnels are made of masonry and concrete. Water drawn from the reservoir during normal working will flow in pipes controlled by means of valves, &c., situated in two valve shafts, one on each discharge tunnel. These shafts, 12ft. in diameter, are made of concrete lined with bricks, those on the face being of the white glazed variety. Three inlets have been provided in each shaft, at different levels, through which water can be drawn off from the reservoir, according to circumstances. The valves which control them are in duplicate and in tandem, the one nearest the reservoir in each instance being available for operation by hand gearing in an emergency,

whilst the other, for general use, will be worked by hydraulic power.

These inlets are all connected with a vertical standpipe, which extends down to the bottom of the shaft. There it is connected to the outlet pipe, 36in. diameter, which, together with a second tunnels to a depth of 9ft. or within 3ft. of the top of the arches, thus indicating that the provision for dealing with contingencies of this character has not been unduly overestimated.

The overflows, two in number, consist of bellmouths, 80ft. diameter at the top, gradually in masonry steps which take the place of the usual smooth surface. Apart from economy in construction, it has been found that such a type of design exercises no adverse influence on the discharging efficiency, but rather the reverse. The cills of the overflows are surmounted by



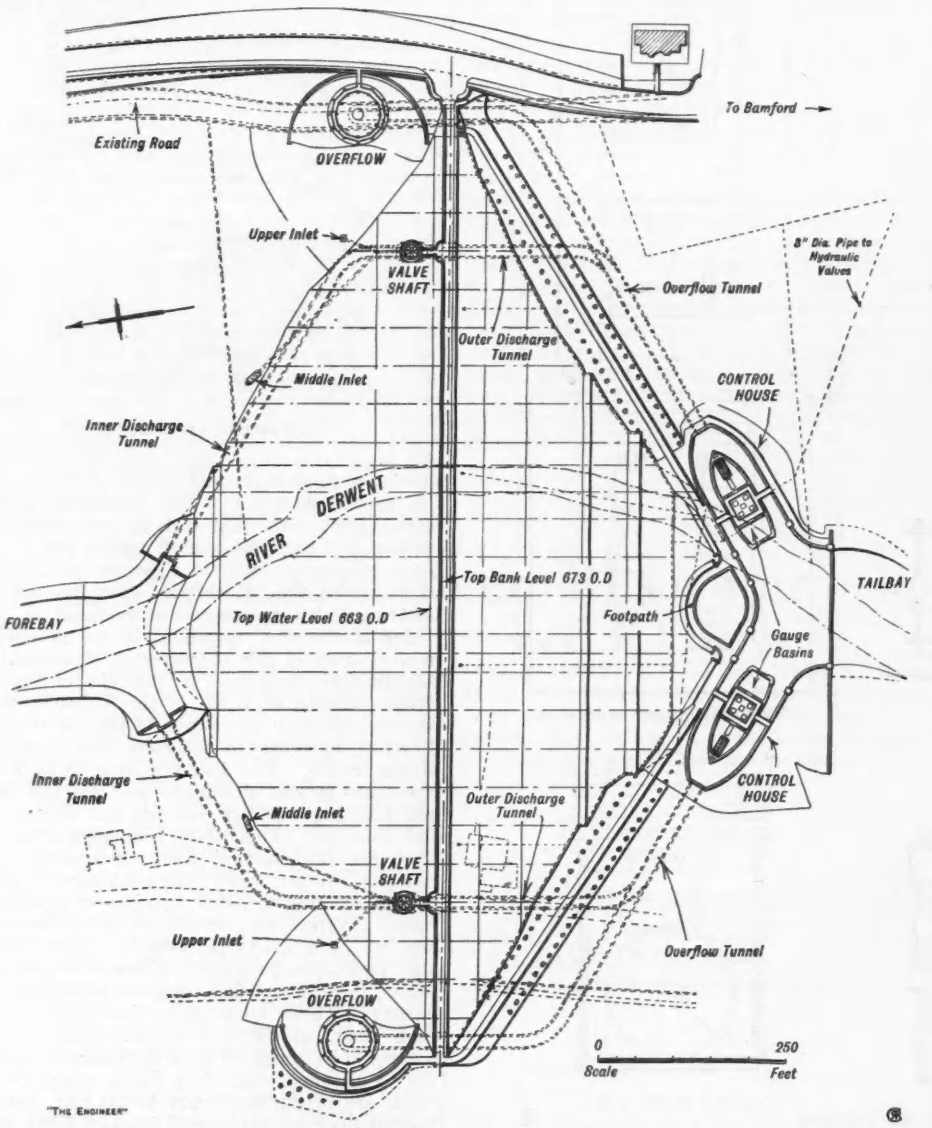
SECTIONS SHOWING DISCHARGE AND OVERFLOW TUNNELS

main leading from the bottom of the reservoir alone, extends down the discharge tunnels to the tailbay. During the progress of the work several large, but by no means maximum, floods have taken place, and water has passed through these diminishing to 15ft. at the point where they merge into the vertical shafts. At the bottom of the shafts they are in turn connected to horizontal tunnels which discharge their contents into the tailbay. The interior of each bellmouth is formed bridges, the piers of each of which, twelve in number, form radial cutwaters, which effectually prevent any tendency of the water passing down the shafts to swirl during transit. The bridges themselves, by facilitating access, will enable any obstructions to the flow of water to be dealt with. Besides the ordinary obstructions to be expected in other parts of this country it is not unusual for ice floes which severe winter weather is apt to produce in the upper valleys of the Pennine Chain to be carried as far down as Ladybower.

In order to make certain that the design adopted for these overflows would produce the results anticipated, the Engineering Department of Manchester University, under the direction of Professor Gibson, constructed models to scale and tested the discharging efficiency. As a result, no doubt at all is left that the overflows will be quite capable of passing all the water to be dealt with at the peak of the highest flood which could be conceived, without any undue rise in the depth of water in the reservoir.

The tailbay into which the discharge and overflow tunnels converge is constructed of stonework, and contains houses of the same material, wherein valves, meters, &c., are provided for controlling and measuring the water drawn from the reservoir, either for supply or compensation purposes. In addition, accommodation for pumping machinery is afforded by these houses, so that water for supply purposes can be pumped as required from the Ladybower reservoir up to the existing aqueduct through which, at a higher elevation, the service is maintained.

Work on this contract was begun in 1935, and is due to be completed in 1941. On page 448 we publish three views illustrating its progress.



GENERAL PLAN OF LADYBOWER DAM

TUNNEL STERN MOTOR LIGHTERS FOR AFRICAN RIVER SERVICE.—In our issue of January 27th we described a 50ft. twin-screw Motor Lighter, supplied by John I. Thornycroft and Co., Ltd., for the transport of equipment and native labour employed in the mining industry. With the development of this form of transport, the owners have now placed further orders with Thornycroft's for three boats. One of these, of 50ft. in length, is generally similar to that already in use, the others being each of 35ft. The boats, which will be built of teak, will be shipped from this country in sections. This somewhat unusual method of construction was adopted in the case of the boat first supplied, the object being to facilitate transportation overland from the port of arrival to the river, where the craft are reassembled. In the larger boat twin Thornycroft 4-cylinder petrol engines, each of 30–70 B.H.P. will form the propelling machinery, and a single unit of the same type will be installed in the 35ft. boats. Owing to the necessity for restricting the draft to about 18in., the tunnel form of stern will be adopted, the tunnels being fitted with inspection ports over the propellers. The 50ft. boat will carry about fifty natives and the 35ft. boats about thirty each.

Continuous and Batch Type Bright Annealing Plant

ONE of the largest steel undertakings in the Sheffield area is the firm of Arthur Lee and Sons, Ltd., whose manufacturing organisation, started over seventy years ago, now covers thirty acres of land. As a result of various extensions carried out from time to time, the Company's mills are equipped with the latest design of plant for the manufacture of bright bars and wires of diameters from 3in. down to hair thickness and flat wire and strip from 1/64in. up to 30in. wide.

Among the most recent extensions is a new mill at the Meadow Hall works where, in addition to hot rolling mill plant, a comprehensive installation of electric furnaces has been installed for the heat treatment (principally bright annealing) of cold and hot rolled steel strip. These furnaces comprise a large unit of the continuous roller hearth type and four vertical cylindrical units of the Grunewald type, all supplied by The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, and manufactured at the Company's Fraser and Chalmers Engineering Works.

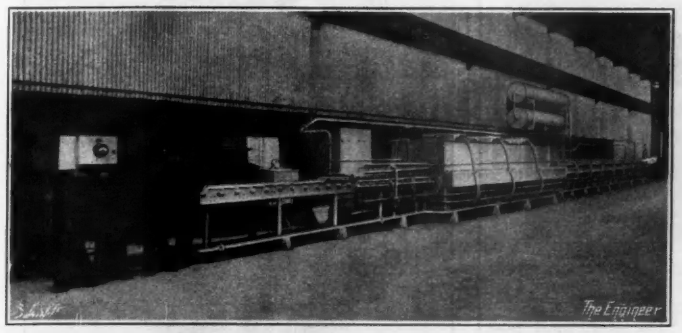


FIG. 1—CHARGING END OF CONTINUOUS FURNACE

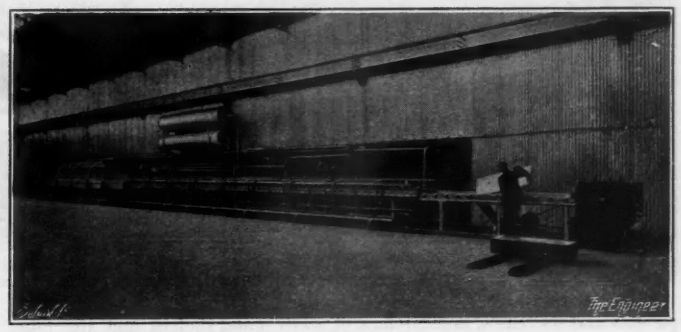


FIG. 2—DISCHARGING END

The continuous roller hearth furnace (Figs. 1 and 2) has been in regular operation for over 12 months and is giving very satisfactory service. This furnace is designed for the continuous bright annealing of cold rolled strip and also for the normalising and descaling of hot rolled strip in lengths. It is suitable for operation at temperatures up to 1000 deg. Cent., and the normal output is 15 cwt. per hour. The internal width is 2ft. and the overall length 114ft., which includes charging and discharging tables, heating chamber, entrance and exit vestibules, and cooling chambers.

Designed for use with an atmosphere of hydrogen and nitrogen, the furnace is supplied from an I.C.I. cracked and burnt ammonia regenerative-type plant shown on the left in Fig. 3. Special features are incorporated in the furnace vestibules to reduce the end losses to a minimum. The heating elements are arranged in the roof and in the hearth of the heating chamber, which is effectively insulated to minimise heat loss. The elements are arranged in three independently controlled zones, connected to a low voltage supply from step-down transformers on a 6600-volt three-phase 50-cycle system. They are constructed from the highest grade nickel chrome strip, wound in sinuous form.

Each heating zone is provided with automatic temperature control gear, the equipment comprising three Cambridge direct deflectional type regulators together with push button control switches, red and green pilot lamps, time switch, &c., all mounted on the front of a floor fixing cubicle. The temperature control instruments give a clear indication of the temperature and are capable of being pre-set to suit particular requirements.

Throughout the whole length of the furnace the roller hearth is capable of being driven over a speed range of 12 : 1, thus enabling the same output to be obtained with different thicknesses of strip. The roller hearth is divided into sections, each of which is connected by a fixed reduction gear unit to a main line shaft running underneath the furnace. A 7½-H.P. G.E.C. squirrel cage motor drives the line shaft through variable speed reduction gearing. The rollers in those parts of the furnace subjected to heat are made of special nickel chrome alloy; elsewhere they are of mild steel. The chains and roller bearings are provided with automatic lubrication throughout. The lubricating points are fed by gravity from a tank situated well above the furnace, and the oil on its return is sent back to the feed tank by a small rotary pump driven from the main line shaft.

The cooling sections are divided up into units, each having a separate water supply, which enables the amount of cooling water passing through the chambers to be adjusted to the requirements of the particular section. All the contactor gear is enclosed in a steel plate case provided with doors giving front access.

The batch type annealing plant comprises four G.E.C. vertical cylindrical Grunewald electric furnaces with automatic temperature control gear and a number of Grunewald bright annealing pots. One of these furnaces is of particular interest in that it was the first installation of its kind in Great Britain for the bright annealing of steel. Since its installation, two repeat orders have been carried out for Arthur Lee and Sons, Ltd., and many similar equipments have been supplied to other steelworks for this class of work.

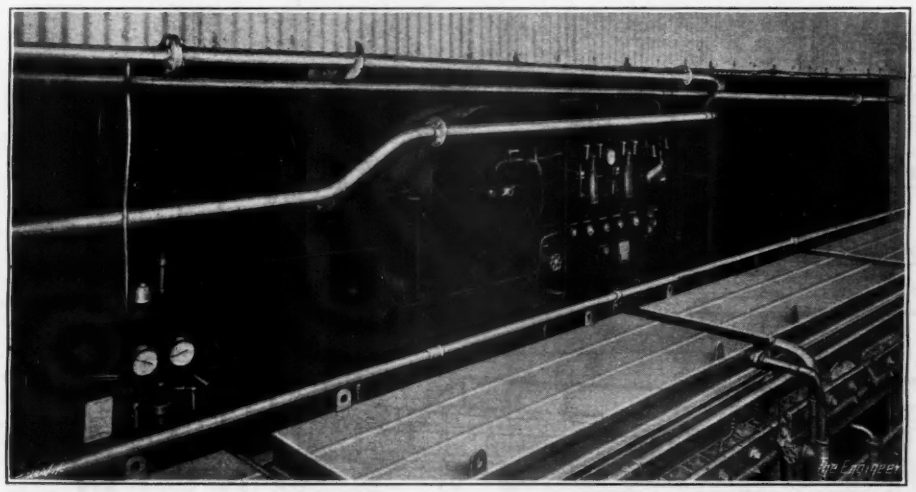


FIG. 3—REGENERATIVE GAS PRODUCER

Each furnace has an electrical rating of 88 kW and has several interesting features which are peculiar to the Grunewald process. The most important of its features are the effective method of sealing the pots and the extremely precise temperature control obtained. Further, the charge is suspended from the underside of the pot cover and is not supported by the pot envelope, which is consequently made of thin heat-resisting alloy of comparatively low thermal capacity, resulting in a high overall thermal efficiency.

Each pot is sealed by a rubber ring which is cooled from the outside by a trickle of water. The automatic temperature control gear enables the furnace automatically to maintain any desired temperature within narrow limits. The whole of this equipment is carried on a polished panel, and comprises a Cambridge direct deflectional type controller working from a thermo-couple situated on the furnace, together with pilot lamps and switch and fuses for the control circuit. Incorporated in the controller is the necessary mechanism for tilting a small mercury switch which makes and breaks the contactor coil circuit, a red pointer being provided for setting purposes. A time switch is included which switches the furnace on or off automatically at any pre-determined time. An additional Cambridge indicating pyrometer is provided on the control panel. This works from a thermo-couple situated in the middle of the charge in the pot, thus indicating the temperature of the charge.

The switchgear consists of a pedestal-mounted oil switch and an air-break contactor, the latter being mounted in the steel cubicle previously mentioned. The contactor, in this particular instance, cuts in and out a portion of the load just before the set temperature is reached—thus avoiding any over-shooting of the set temperature.

The determining factor in the installation of these furnaces was the quality of the work produced, and in this respect they have, we are informed, fully justified themselves. Moreover, they are stated to have proved an economic proposition, considered on a combined time and fuel basis. Each pot takes a charge of approximately 30 cwt., the time of treatment being 6 hours as against the 24 hours required with the standard method.

Large Boiler Installation

A NEW four-drum Stirling boiler, recently installed in the City of Edmonton power plant, is one of the largest in Canada fed by a travelling grate stoker. It weighs well over 600 tons and stands over 60ft. in height. It has a steaming capacity of 155,000 lb. per hour and is operated at a pressure of 400 lb. per square inch at a temperature of 750 deg. Fah. This boiler was especially designed to burn local coals efficiently, and from tests made has more than come up to the manufacturer's performance. The coal is fed to the furnace by a twin stoker, which is believed to be the largest of its kind in either North or South America. At full rating there will be over 13 tons of coal per hour going through the furnace. There are two fans, one a forced draught fan, supplying air to the furnace, and one an induced draught fan, removing the products of combustion. The air to the forced draught fan can come from three sources, the main one of which is from the front and side walls of the furnace. It can also get air from the fan room or from the outside atmosphere. After leaving the fan the air is forced through an air preheater on its way to the stoker. The gases from the boiler are led through the air preheater and thence to the induced draught fan, which discharges through the stack. The furnace designed for this boiler is 28ft. wide and has a volume of 7100 cubic feet. This gives a heat release at full load of slightly over 33,000 B.Th.U. per cubic foot per hour. In asking for a furnace of such liberal dimensions the purpose was to eliminate as far as possible excessive maintenance costs in the furnace.

The boiler control board enables the operator to see at all times the actual conditions obtaining in the boiler. He can see the pressure and temperature of the steam, the water level in the boiler, the temperature of the air and gases entering and leaving the preheater, the air pressure in each stoker compartment, and can tell what the combustion conditions are in the CO_2 indicator and recorder. He can also see how much steam he is supplying to the plant and has an integrator on the boiler meter to give readings in pounds of steam.

NEW COAL DRIFTS IN LANARKSHIRE.—New coal drifts have been opened in Lanarkshire at East Kilbride and Newhouse. The mines have an estimated combined initial output of 110 tons a day.

A Jet-Propelled Motor Lifeboat for Minehead

MORE than usual technical interest attaches to the new motor lifeboat "Kate Greatorex," recently completed for service at the Minehead Station of the Royal National Lifeboat Institution, which is the first of the Surf Type to be equipped with Gill hydraulic propulsion. Proposals for the propulsion of ships by the reaction developed from water jets are of very early origin, as might be expected from the device being found in many aquatic organisms. Until recent years, however, two factors have mitigated against the application of this system, namely, an incomplete understanding of its limitations and its possibilities on the part of many of its exponents and its critics, and the lack of really suitable pumps and discharge apparatus, for bringing out its good points.

THE JET-PROPELLED LIFEBOAT "KATE GREATOREX"

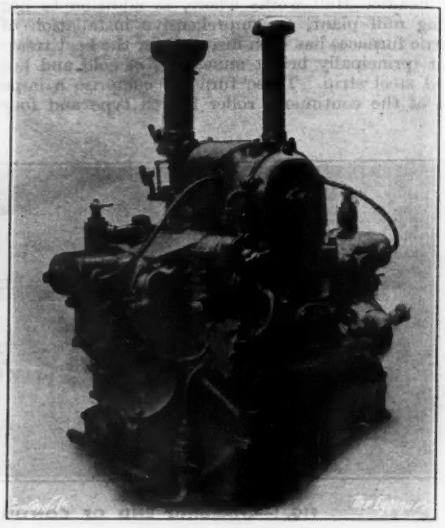
For several years past the Royal National Lifeboat Institution, whose very first power-driven lifeboat of 1890 was "The Duke of Northumberland," built by Greens, of Blackwall, and propelled by reaction jets from steam engine-driven centrifugal pumps, following the proposal and designs of the late Joseph F. Green, has kept in close touch with the development of the Gill hydraulic propulsion unit, which it has adopted for the new Minehead lifeboat herewith described and shown in the engraving above and the accompanying drawing.

Hull Design and Equipment

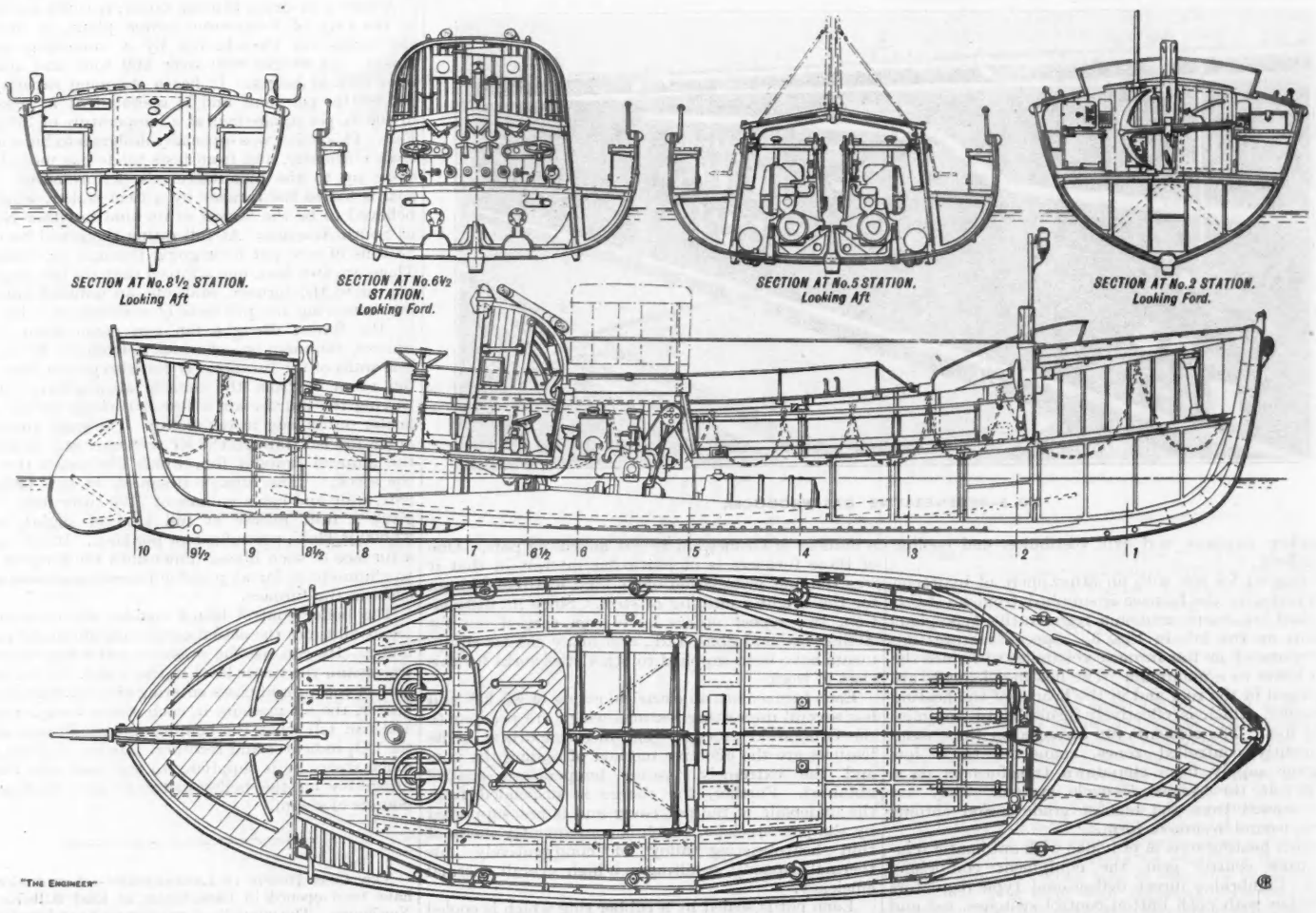
The boat, which was designed by the technical staff of the Institution, was built at East Cowes in the shipyard of Grove and Gutteridge, Ltd, under Institution supervision. It has a length of 32ft., with a beam of 9ft. 3in. to the outside of the skin. The extreme depth amidships is from 3ft. 10in. to 4ft., with 5ft. 9in. to 6ft. at the stem and 5ft. 6in. to 5ft. 8in. at the stern post. Under service conditions the displacement is from 4¼ to 4½ tons. The hull is made of double skin mahogany, each plank lying at an angle of about 45 deg. to the line of keel amidships, the two thicknesses being at right angles to each other, with calico and thick white lead laid between the skins. The keels of the boat are made from Canadian rock elm, which wood also serves for the frames and timbers, the gunwhale, the rising deck shelves and the bilge keels. The stem and post aprons, the deadwoods, and the after end of the framing for the propeller tunnels are made from English oak grown to form. The bulkheads around the engines and fuel tanks are also made of double mahogany, as are also the decks, the hatches of which are supported on mahogany beams. This somewhat unusual method of construction is adopted in order to facilitate easy access to the hold and air cases. In lifeboat work it has been observed that it is usually the second sea which tends to capsize a boat after the first one has filled the decks and has so rendered the boat more or less unstable. For this reason safety has been sought by adopting a design which has the following characteristics:—Ample freeboard, a large righting lever, hull subdivision by air cases, restriction of free water space on deck, and a large number of scuppers or freeing ports. As the motion resulting from such a design of boat in a seaway is likely to be very lively, additional safeguards for the crew, such as lashings, life lines, and guard rails are provided. In the case of the type of surf boat we are describing, between eight and ninety air cases, which are for the sake of lightness made of red cedar, and only weigh altogether between 7 cwt. and 7½ cwt., are used. The boat has eighteen scuppers, which are designed to free her deck from all ordinary seas within 6 sec. These scuppers have been adopted instead of the older pattern of relieving valves and tubes, as being above the deck they can never give rise to leakage in the bottom of the boat.

Propelling Machinery

The propelling machinery comprises a twin-screw arrangement of a special design of horizontally opposed flat twin-cylinder engine, driving the Gill propelling units through reduction gear. The engine, a view of which we show in the accompanying engraving and drawing, was designed by the engineering staff of the Institution and was built by the Weyburn Engineering Company, Ltd., of Elstead, Surrey. Like other engines of Institution design, it is fully submersible. In its original form it was designed for propeller or Hotchkiss propulsion, and in that form had an integral reverse and reduction gear with an overall gear ratio of 4 to 1. In order to suit the higher revolutions required by the Gill pump, the reduction gear has been modified to a 2 to 1 ratio, and since

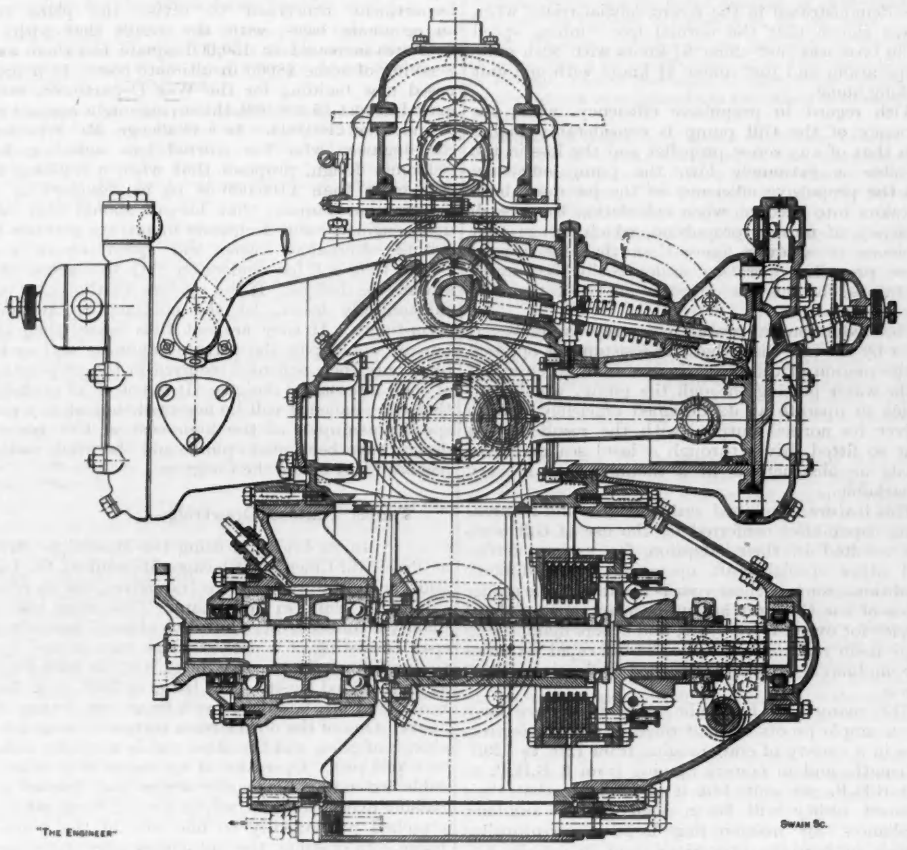


PROPELLING ENGINES

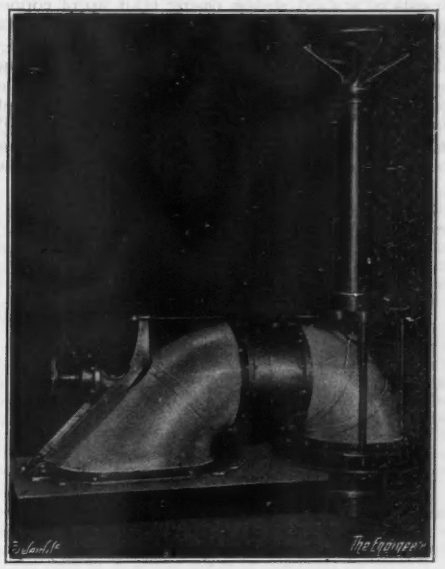


SECTIONS AND PLAN OF LIFEBOAT

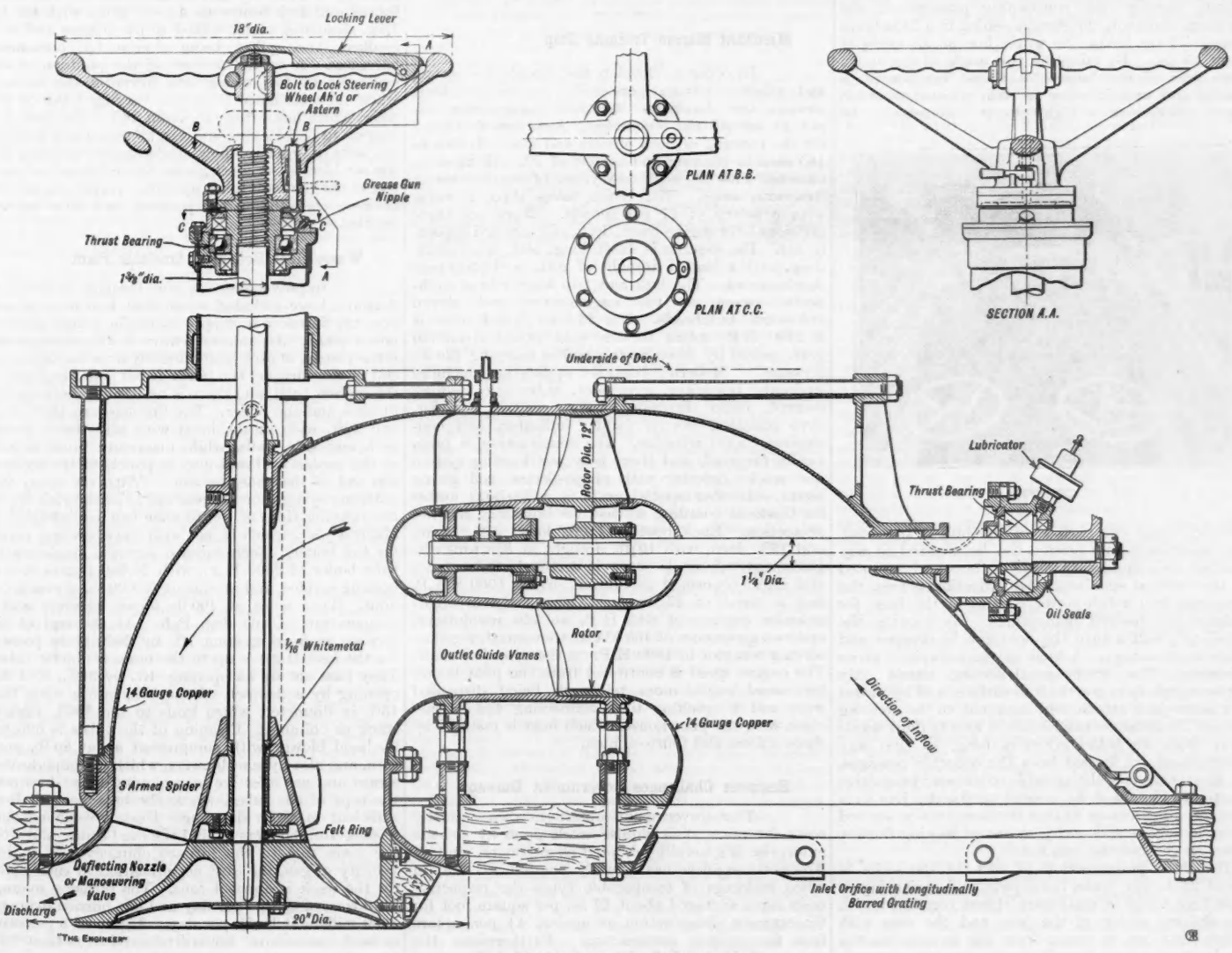
with the Gill unit no reverse gear is required, that gear has been omitted. The engine was originally designed for continuous full-load operation at a speed of 3000 r.p.m., but in the present installation it has been rated down to 2400 r.p.m., and drives the Gill pump at approximately 1200 r.p.m., at which speed an output of 13 B.H.P. is delivered to the pump. As will be seen from the accompanying drawing, the speed of the engine is reduced by means of a chain drive from the crankshaft of the engine to a shaft, on which there is carried a bevel pinion, which meshes with a crown wheel mounted on the inner member of a plate clutch on the driving shaft. The two cylinders of the engine are arranged in a fore-and-aft direction, with the main crankshaft athwartships. For the crankshaft bearings, heavy-duty roller bearings are employed, the connecting-rods having white-metal-lined shells. The lubrication of the main crankshaft bearings and the connecting-rod bearings is effected by means of a pressure system, jet lubrication being employed for the other working parts. The engine has been arranged for symmetrical handling, and should the direction of rotation of the engine be required in the opposite sense, it is only necessary to alter the camshaft and the driving gears for the magneto, a matter of spur gears and chain wheels only. As will be seen from the drawing of the engine we reproduce, the cylinders, which have a bore of 3·05in. and a stroke of 3·375in., have side valves, and are furnished with detachable cylinder heads. The tappet mechanism is enclosed within easily detached doors, and the sparking plugs in the cylinder heads have water-tight boxes with detachable lids. A down-draught carburetter of the Zenith pattern is fitted, and is attached to a distribution box with a hot spot heated by the exhaust from the engine. The magneto, which is of the Lucas type, is enclosed in a split casing with a removable top half, giving easy access for adjustment or removal. The water circulating pump and the duplex oil pump are mounted at



SECTION OF ENGINE



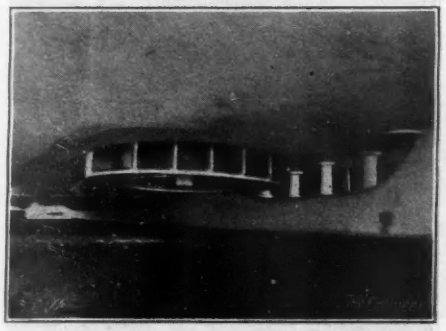
HYDRAULIC UNIT



GILL HYDRAULIC PROPULSION UNIT

the opposite ends of the spiral gear-driven cross shaft. The petrol is transferred from the fuel tanks to the carburetter by a small air pump worked from an excentric cam mounted at the end of the camshaft. The revolution counter is driven from the end of the shaft which drives the magneto.

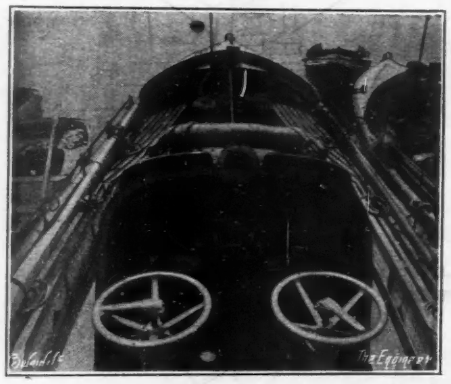
Propulsion is effected by twin 12in. diameter Gill hydraulic units, which are arranged one on each side of the keel of the boat under the after well deck. An engraving on page 445 shows one of the units, and we also reproduce a section through a unit showing some details of construction. It will be seen that the unit consists of a short siphon casing built up of copper sheet of 14 gauge thickness, which contains the horizontally arranged Gill pump, and on the outlet side connects with a circular bellmouthed opening through the bottom of the boat and housing the deflecting nozzle. As is shown by the photograph reproduced below, the keel of the boat is cut through and replaced by pedestals so that the discharge can operate athwartships. The oblong intake orifice



DEFLECTING NOZZLE

is protected by a longitudinally barred grating. The pump is of the Gill standard axial-flow pattern, and is generally similar in design to the pumps now extensively employed for circulating water duties in naval vessels and in power stations. The accompanying drawing and photographs also show the design of the rotatable multi-jet deflecting nozzle which is mounted at the bottom of the vertical steering spindle.

The action of the device may well be described as operating by accelerated siphonic flow. The water, it will be noted, is drawn in at a mean angle of about 60 deg. to the water line, and then passes horizontally through the pump being discharged at a higher velocity through the contracting passages of the discharge deflector, the stream issuing in a broad and flattened form below the water line at an angle of about 15 deg. By adopting this angle of discharge, very little of the horizontal thrust component is wasted and any increase in skin resistance which might result were a high-velocity discharge to be



COCKPIT

directed along the surface of the hull is obviated. As the issuing water stream can be directed to any point of the compass, by turning the wheel mounted on the vertical spindle of the deflecting nozzle, the steersman has a full-power control of the boat for making any desired manœuvres. By moving the wheel only half a turn the boat can be stopped and made to go astern. A view of the cockpit is given herewith. The discharge deflecting nozzle only projects slightly below the hull surface, and by means of a screw jack attachment mounted on the steering column the deflector can be moved axially downwards away from its bellmouthed housing, so that any obstructions are flushed from the deflector passages. By this means it is also possible to suspend propulsive reaction. Should it be desired to fix the jets in a fore-and-aft direction so that the boat can be steered by rudder, this is done by means of locking devices fitted on the steering spindles.

The dead pull reaction of each of the units is about 24 lb. per brake horse-power of engine input. This high value of stationary thrust combined with the sluicing action of the jets, and the ease with which these can be swung from side to side, enables the boat to refloat herself should she run aground. By turning the jets either directly towards or directly away from each other, the boat can be held stationary, while by turning both jets outboard it becomes possible to hold up the boat against another vessel or a quay without tying up.

These useful characteristics for lifeboat service were demonstrated in the recent official trials, when it was shown that the normal free running speed of the boat was just under 6½ knots with both units in operation, and just under 5½ knots with one unit working alone.

With regard to propulsive efficiency, while the efficiency of the Gill pump is considerably higher than that of any screw propeller and the loss in the deflector is extremely low, the pump efficiency and the propulsive efficiency of the jet must both be taken into account when calculating the overall efficiency of normal propulsion, which brings that efficiency to a lower figure than that for a good screw propeller operating under really favourable conditions, for this has only one efficiency figure to be considered.

The reduction in overall efficiency is, however, offset by the fact that whatever resistance is opposed to the motion of the boat, there can be no churning of the water passing through the pump, which continues to operate at its designed efficiency and to deliver its normal output, with the result that a boat so fitted drives through a head sea and over shoals or obstructions in a manner that is very remarkable.

This feature, combined with the all-round manœuvring capabilities conferred by the use of Gill units has resulted in their adoption for various ferries and other special craft operating under difficult conditions, some of these vessels fitted with the earlier types of the Gill unit having been in constant hard service for over twelve years, and others maintaining large main road ferry services across rapid estuaries in Scandinavia frequently impeded by floating ice and *débris*.

The many Gill hydraulic units in service have given ample proofs of their reliability and effectiveness in a variety of craft ranging from 12ft. to 120ft. in length, and in powers ranging from 3 B.H.P. to 100 B.H.P. per unit, but it is probable that their greatest utility will lie in their use as auxiliary appliances for manœuvring large screw-propelled vessels in berthing operations, and in canals, &c., where tugs and other aids are now employed.

American Engineering News

Merchant Marine Training Ship

In order to develop and maintain a strong and efficient citizen personnel for the merchant service, the American Maritime Commission has put in service the steamship "American Seaman" for the training of both officers and men. It carries 165 men in training and a crew of 70. All must be citizens, with at least two years of sea service in American ships. The cruise takes three months, with a salary of £7 per month. There are three divisions—for engine-room, deck, and steward departments. The steamer is 423ft. long, 54ft. beam, 38ft. deep, with a loaded draught of 20ft. on 10,500 tons displacement. The hull had two longitudinal bulkheads—except at the engine-room—and eleven transverse bulkheads. For 12-knot speed there is a 2500 H.P. steam turbine with double-reduction gear, served by three Scotch boilers carrying 220 lb. pressure. Modern control apparatus includes hydraulic telemotor, gyro-pilot, automatic steering control, radio direction finder, electric sounder, gyro compass, electric rudder indicator, and continuous course recorder. The construction is practically fireproof, and there is a gas flooding system and smoke detector with photo-electric cell giving alarm.—Another special craft is a harbour cutter for Customs boarding service, ice breaking, and fire protection. Each boat is 110ft. long, 27ft. beam, and 15ft. deep, with 10½ft. draught at 328 tons displacement. A single screw is driven by oil engines and direct-connected generators, giving 1000 S.H.P. and a speed of 12 knots. There are two eight-cylinder engines of 640 H.P. at 750 revolutions, and two generators of 400 kW at that speed, together serving a motor of 1000 H.P. on the propeller shaft. The engine speed is controlled from the pilot house, the usual engine-room telegraph being dispensed with and a speaking tube connecting the engine-room with the pilot house. Each boat is manned by three officers and fourteen men.

Engineer Challenges Government Bureaux

That Government construction work usually costs far more than similar work done by private enterprise is generally accepted as axiomatic, and an American engineer has recently pointed out that in office buildings of comparable types the respective costs have averaged about £2 5s. per square foot for Government construction as against £1 per square foot for private construction. Furthermore, the structural design of the former is usually adapted to fit an architectural exterior design, rather than to economic engineering principles. He cites among specific cases a structure which—as designed by a certain bureau—was to have 100,000 square feet of floor area and to cost £200,000. Later, the engineer in question was called in by the Department concerned to revise the plans on an economic basis, with the result that with a floor area increased to 150,000 square feet there was a saving of some £8000 in ultimate cost. In a proposed new building for the War Department, estimated to cost £5,400,000, the saving might amount to as much as £100,000. As a challenge, Mr. Wheeler, the engineer who has started this agitation for economic design, proposes that when a building to cost more than £100,000 is to be designed by a Government bureau, that bureau should also call upon engineers and architects in private practice to submit alternative plans and specifications, and should then call for tenders on both the official and alternative designs. If the tenders for the latter are substantially lower, let the contract be awarded accordingly. If they are not thus lower, then the bureau would pay the private engineers and architects only their expenses incurred in the preparation of their alternative designs. It is not at all probable that the challenge will be accepted, but at any rate specific examples of the high cost of Government design have been made public and the whole matter has been laid before the Congress.

Timber Pontoon Drawbridge

In its bridge crossing the Mississippi River at Prarie du Chien the Chicago, Milwaukee, St. Paul and Pacific Railway has two draw spans, one on either side of an island in midstream. The bridge itself is mainly a timber trestle, but each channel has a draw-span consisting of a decked barge surmounted by a timber framework to carry the rails at the same height as on the fixed trestle. The barge is 209ft. long, 55ft. beam, and 6ft. 6in. deep, with transverse frames 2ft. apart. One of the downstream corners is hinged to a cluster of piles, and the other end is normally locked to a pile pier. Operation is by means of a chain or cable extending diagonally across the channel and passing over a steam winch on a small barge which is attached permanently to one side of the pontoon barge. In opening, the rail connections are released and the lock withdrawn, the pontoon then swinging downstream around its pivot, assisted by the current. Last winter the pontoon was largely rebuilt with creosoted fir, having a retention of 12 lb. per cubic foot. With navigation closed by ice, the pontoon was floated away and a temporary pile trestle built to carry the railway across the channel. The cross frames and deck beams are 4in. by 12in., with 4in. by 10in. sheathing plank spiked to the frames and well caulked, the spikes being driven by pneumatic hammers. A special feature of the pontoon is the arrangement for raising and lowering the railway track in accordance with the varying level of the river, which has a range of about 16ft. The posts are supported on blocking and can be raised and lowered by jacks in order to allow of placing or removing the timber blocks. A steel girder apron hinged at each end of the pontoon takes up minor variations in level between the rails on the pontoon and those on the trestles.

Waste Heat Boilers at Smelting Plant

Improvements at the Douglas smelter, in Arizona, have included waste heat boilers on reverberatory furnaces to supply steam for a high-pressure power plant. An unusual feature in the arrangement is the placing of each boiler directly over the skimming end of the furnace, the boiler tubes being exposed to the molten bath, and there is no damper between the furnace and the boiler. The furnaces are 107ft. long and 26ft. wide inside, lined with silica brick in the arch and side walls, while magnesite brick is used in the bridge wall and also in panels of the walls at the end of the charging zone. With the spray gun patching system for the renewal of silica brick arches the running time of the furnace can be extended to about a year, which agrees with the operating period for the boiler. Each furnace serves a single water-tube boiler of 2600 H.P., with 25,680 square feet of heating surface, and producing 60,000 lb. of steam per hour. They work at 400 lb. steam pressure and a temperature of 460 deg. Fah. At the end of the furnace arch an opening 7ft. by 28ft. gives passage for the heated gases up to the nests of boiler tubes. They pass out by an opening, 4ft. by 30ft., to a flue opening by a damper, 8ft. square, into a main flue, 15ft. in diameter, which leads to the 300ft. furnace stack or chimney. Cleaning of the tubes is effected by hand blower with compressed air at 80 lb. pressure, and also by soot blowers, which use superheated steam and are effective in removing loose dust near the tops of the tubes, where the heat has not been sufficient to cause sintering. Dust is removed once a week from hoppers behind the mud drum, and from the main flue to the furnace chimney. With low velocity of gas, the dust accumulation in each boiler for the week is about 4 tons. The furnaces average 1016 tons of charge per day and gas burned averages 3030 million B.Th.U. per day. A gain of 8 per cent. in heat unaccounted for is attributed to radiant heat from the incandescent slag bath.

Rail and Road

NEW YORK UNDERGROUND.—A contract to permit New York City to purchase the Interborough-Manhattan subway system for 155 million dollars has been signed.

THE SEVERN BRIDGE.—It is announced that the reconstruction of the Westgate Bridge which carries the main Gloucester–South Wales Road over the River Severn at Gloucester is to be deferred.

RAILWAY ACCIDENT IN MEXICO.—When a freight train from Vera Cruz was derailed between Santa Lucrecia and Matias Romero on Saturday, October 21st, two petrol tank wagons caught fire. A number of people were travelling in the good wagons and it is reported that forty of them lost their lives.

CANADIAN RAILWAY ORDERS.—Contracts to the value of about 25 million dollars have been placed by the Canadian Defence Purchasing Board for railway equipment including 49 locomotives and 4575 freight cars. Of this equipment, 15 million dollars worth is for the Canadian Railways and 10 million dollars worth for the Canadian Pacific Railway.

L.N.E.R. SUBURBAN LINE FLOODED.—Traffic on the London and North Eastern Railway between Bruce Grove and Seven Sisters stations was suspended for several hours on the morning of Tuesday, October 24th, as a result of flooding. The line passes through a cutting which was flooded as a result of a broken water main near White Hart Lane station. Normal services were resumed early in the afternoon.

TRAMS AND GOODS TRAFFIC.—The practice of using the tramways at night for goods traffic is growing in Moscow. When the passenger trams return to their depots at night they are replaced by open goods-trams, which deliver bricks, cement, and other building materials to the different building sites en route, and take away excavated earth on their return journeys. To a lesser extent goods-trams are also used on the tramways during the daytime.

NEW RAILWAYS IN U.S.S.R.—According to the Russian press the following new railway lines have been completed and placed in service: Karaganda–Balkhash, 303 miles long; Vralsk–Iletsk, 163 miles long; and Rubtsovka–Ridder, 209 miles long. The following single tracks have now been doubled and are in service: Biriulevo–Valuiky, 416 miles long, and the Valuiky–Balashov–Penza, 447 miles long. The provisional opening is announced of the 260 miles long Meldy–Jezkagan line and the 94 miles long Sinarskaya–Chelyabinsk line.

UNDERGROUND RAILWAY PROTECTIVE WORK.—The emergency protective works being carried out at the closed stations of the Underground Railway in London are expected to be completed within the next few weeks. It is hoped to reopen all the stations with the exception of Maida Vale, where the works will take longer, before the end of December. Work on the floodgates on the Northern line at the Strand station are rapidly approaching completion, and the protective works at the platform entrances of the Bakerloo and Northern lines at Charing Cross are expected to be completed soon after.

STREET LIGHTING IN LIVERPOOL.—Two hundred street lamps specially designed for black-out conditions by Mr. P. J. Robinson, the city electrical engineer of Liverpool, are to be erected near the centre of the city. According to a report in *The Times* at the final test observers 80ft. above ground level said they saw nothing of the light below, and other observers driving motor-cars said there was sufficient light to guide them. It is claimed that it was possible to see a pedestrian crossing in front of the car 20 yards away, yet there was no pool of light in the roadway. The new lamps are smaller than the ordinary street lamps of the city and can be erected on existing standards. They will be placed at a height of 12ft. instead of the normal 20ft.

NEW AMERICAN LOCOMOTIVES.—The American Locomotive Company is delivering fifteen new 4–8–4 high speed passenger and freight locomotives to the Union Pacific Railroad. The leading dimensions of the new engines are as follows:—two cylinders 25in. diameter by 32in. stroke; 12in. diameter piston valves with a maximum travel of 7in.; boiler pressure 30 lb. per sq. in.; total evaporative heating surface 4470 sq. ft.; superheater heating surface 1900 sq. ft.; grate area 100·2 sq. ft.; driving wheel base, 22ft.; engine wheel base 60ft.; driving wheel diameter 80in.; weight in working order 483,000 lb. These new engines are a development of twenty 4–8–4 locomotives supplied by the company in 1937. It was one of the original engines which attained the highest speed in the American Association of Railroads tests when it hauled a 16-coach 1000 ton train at speeds of 89 and 102 miles an hour in opposite directions on the same length of line. The engines are designed to operate continuously under maximum horse power output at 90 miles an hour.

L.M.S. TRAIN SERVICE IMPROVEMENTS.—Accelerations ranging from 14 to 64 min. were made by the London, Midland and Scottish Railway Company on Monday, October 30th, in some of the principal expresses between London (St. Pancras), Nottingham, Sheffield, Leeds, and Bradford. The 7.20 a.m. from Bradford now arrives St. Pancras at 1.10 p.m. instead of 2.14 p.m., giving accelerations of 1 hr. 4 min. from Bradford, 55 min. from Leeds, and 46 min. from Sheffield to London, also providing an additional service at 10.12 a.m. from Nottingham to London. The 12.30 p.m. from Bradford now leaves at 12.20 p.m. and arrives St. Pancras at 6.33 p.m. instead of 7.26 p.m., the savings in time for travellers to London by this service amounting to 43 min. from Bradford, 52 min. from Leeds, 45 min. from Sheffield, and 14 min. from Nottingham. In the northbound direction, the 4 p.m. from St. Pancras now leaves at 4.5 p.m. and reaches Leeds at 9.30 p.m. instead of 10.2 p.m., being also extended to Bradford. Accelerations amount to 32 min. London to Nottingham, 28 min. London to Sheffield, and 37 min. London to Leeds. Limited first-class sleeping-car accommodation is now available on the 10.55 p.m. Euston to Preston and 11.10 p.m. Preston to Euston services, Saturdays excepted in each case.

Miscellanea

ELECTRICIAN'S WAGES.—As a result of an agreement reached between the Electrical Trades Union and the National Federated Electrical Association, electricians are to receive an increase in wages of 3s. 6d. per week.

PIT DISASTER.—Early in the morning of Saturday, October 28th, a fire damp explosion at Valleyfield Colliery in Fifeshire caused the death of thirty-three miners. A number of men were injured and two others have since died in hospital.

MINERS' WAGES.—At a recent conference between the miners' delegates and coalowners, the delegates accepted a war time wage increase of 8*d.* a shift for men, and 4*d.* for boys and youths. This increase will cost the industry about five million pounds a year.

GAS AND ELECTRICITY RATIONING.—The Government has decided to relax the scheme for the rationing of gas and electricity to 75 per cent. of last year's consumption. A new order permits the same amount to be consumed as in the corresponding period last year.

BRITISH OVERSEAS TRADE RETURNS.—According to the Board of Trade returns for September, this country's imports totalled £49,900,00, exports £23,100,000, and re-exports £2,400,000. Compared with September, 1938, imports showed a reduction of over £25 million, exports a reduction of £16,700,000, and re-exports a reduction of £1,600,000.

THE LATE MR. W. B. GUTHRIE.—We learn with deep regret of the death on Sunday, October 22nd, of Mr. W. B. Guthrie who was well known as chief buyer for Bruce Peebles and Co., Ltd., Edinburgh. Mr. Guthrie's connection with that Company lasted for over thirty-eight years, he having spent the whole of his business career with it.

LANTERN SLIDES.—An interesting series of lantern slides, describing a wide range of repairs to motor vehicle engines, industrial machines, machine tools, and other damaged parts, has been prepared by Barimar Ltd., the welding engineers. The slides, along with the full text of a lecture, will be lent free of charge to Technical Schools, Institutes, and engineering societies, and applications, with suggested dates, should be sent to Barimar, Ltd., 14/18, Lamb's Conduit Street, London, W.C.1.

THE BRITISH ENGINEERS' ASSOCIATION.—At a meeting of the Council of the British Engineers' Association following the Twenty-Seventh Annual Ordinary General Meeting held on the 19th October, 1939, at the Hotel Victoria, London, W.C.2, Mr. Joseph James Carter (managing director of Crossley Brothers, Ltd., of Openshaw, Manchester, and chairman of Crossley-Premier Engines, Ltd., Sandiacre, Nottingham), was unanimously elected president of the Association for the ensuing year.

THE COAL UTILISATION JOINT COUNCIL.—At a recent meeting a resolution was formally passed winding up the Coal Utilisation Council and intimating that its functions would be taken over by the Coal Utilisation Joint Council, a new body on which, in addition to the colliery owners and coal traders, the coal-burning appliance manufacturers and distributors will also be represented. As previously indicated, the scope of the work will be curtailed in some respects during the continuance of the present national emergency, but essential services will still be carried on by the new body. Communications should be addressed to Mr. J. S. Williams, the Secretary, Coal Utilisation Joint Council, Grosvenor Gardens House, Victoria, S.W.1.

PROTECTION OF SANDBAGS.—A method of protecting sandbags against the effects of damp has been recommended to local authorities by the Ministry of Home Security. It consists of placing a water-proof cover, for example bituminous felt, under the top layer of bags, draining the ground at the base so that the pile does not stand in water, and applying either a creosote or tar distillate or a solution of organic copper salt in creosote to the exposed face of the pile. Local authorities have been advised also to put a kerb at the base of sandbag piles to prevent their being damaged by passing pedestrians. The Ministry has drawn their attention also to the danger from erecting revetments too high. As a general rule they should not be higher than 6 to 8ft. and never more than 10ft.

WORLD POWER CONFERENCE.—Sir Harold Hartley, the Chairman of the International Executive Council of the World Power Conference, has asked Mr. G. J. T. Bakker, the Chairman of the Netherlands National Committee, the First Vice-Chairman of the Council, to become Acting-Chairman during the war. Mr. Bakker has consented. The Central Office in London will be closed temporarily, and correspondence intended for the International Executive Council should be addressed to the Secretariat of the Netherlands National Committee:—The Secretariat, International Executive Council, World Power Conference, Vereeniging voor Congressen op Electrotechnisch en Aanverwant Gebied, Utrechtscheweg 210, Arnhem, Holland. Correspondence for the British National Committee should, as at present, be addressed to 36, Kingsway, London, W.C.2. Arrangements have been made for such correspondence to be dealt with, although the office itself has now been closed.

CALCIUM CHLORIDE IN CONCRETE.—A booklet issued by Imperial Chemical Industries, Ltd., deals with the use of calcium chloride for accelerating the hardening of Portland cement. It points out that strengths usually attained at the end of three days with ordinary concrete are generally attained at the end of 24 hours when calcium chloride is used. The ultimate strength is also increased so that at the end of one year it is still appreciably higher than for plain concrete. An approximate idea of the effect of a 2 per cent. addition of flake calcium chloride on the compressive strength of a 1 : 2 : 4 concrete made with an average Portland cement is shown in the following test results: After one day the increase in compressive strength was 120 per cent.; after three days, the increase was 50 per cent.; after one month, 14 per cent.; and after one year, 6 to 10 per cent. It has been found that little advantage is to be gained by adding more than 2 per cent. of calcium chloride to the cement.

Air and Water

AIL MAIL SERVICES.—Air mail services are now in operation between this country and France, Belgium, Holland, Norway, Sweden, and Finland.

SHIPBUILDING IN ITALY.—It is reported that fifteen merchant ships aggregating about 100,000 tons are being built at present in Italian shipyards for owners in Roumania, United States, Mexico, Norway, Yugoslavia, Holland, and Sweden.

IMPROVEMENT WORKS ON THE TYNE.—The Tyne Improvement Commission has decided to suspend work on the new deep water quay at Tyne Dock. The second smaller quay, which is 800ft. long and will cost about £250,000, is to be proceeded with.

PORT OF SPAIN HARBOUR.—The Government has taken over the new deep harbour recently completed by contractors at Port of Spain. The work was begun in 1935 and has involved the reclamation of about 160 acres of land at an estimated cost of a million pounds.

NEW ITALIAN WARSHIP.—The new Italian dreadnought "Impero" was launched on Saturday, October 28th. This ship, which is to be completed in 1942, will carry nine 15-inch guns, twelve 6-inch guns, and twelve 3·5-inch anti-aircraft guns, in addition to a number of machine-guns. Her sister ships the "Littorio" and the "Vittorio Veneto" were laid down in 1937, and another vessel of the same class, the "Roma," was started last month.

SHIPBUILDING IN AMERICA.—At the beginning of October there were 179 vessels aggregating 1,044,580 tons under construction in the United States. Laid up tonnage in the country in June last amounted to 306 vessels, of 1000 tons gross or over, totalling 1,735,561 tons. On the basis of the price for ships recently ordered by the United States Maritime Commission it is estimated that standard ships in that country now cost about £60 per ton gross.

SHIPBUILDING IN JAPAN.—The Japanese Government has decided to permit shipbuilders in that country to build ships for foreign owners. Conditions under which orders may be accepted are that materials for constructing the vessels must be imported and part of the expenses paid in advance; the remainder of the money received must be used for importing raw materials necessary for constructing Japanese vessels; and the building of foreign ships must not hamper the building of Japanese ships.

LLOYD'S REGISTER WRECK RETURNS.—According to Lloyd's Register Wreck Returns, during the quarter ended March 31st last, there was a gross reduction of 144 vessels of 317,705 tons gross register in the Mercantile Marine of the world. Of these 38 ships of 130,132 tons were British. It is shown that 78 ships of 121,100 tons were totally lost, condemned, &c., in consequence of casualty or stress of weather and 66 ships of 196,695 tons broken up. Of the ships broken up, 25 of 111,816 tons were British.

WILLIAM DOXFORD AND SONS, LTD.—At the annual general meeting of William Doxford and Sons, Ltd., Mr. E. P. Andreae said that during the year under review the company delivered seven ships with a total deadweight of 69,950 tons, and nine sets of motor machinery totalling 37,100 brake-horse-power. Various sub-licensees, during the same period, built and delivered from their own works machinery totalling 139,640 brake-horse-power. Dealing with the effects of the slump in tramp shipping, he said that in the latter months of 1938 and early 1939 with each successive launch a berth remained vacant. Fortunately, however, that period of slackness was of short duration, for on March 28th, 1939, the Government's scheme for a British Shipping (Assistance) Bill was outlined in the House of Commons. That announcement brought in a veritable spate of orders for new ships, spread over the whole of the shipbuilding industry, even before the Government's full proposals were made known. Of these orders the company received its fair proportion.

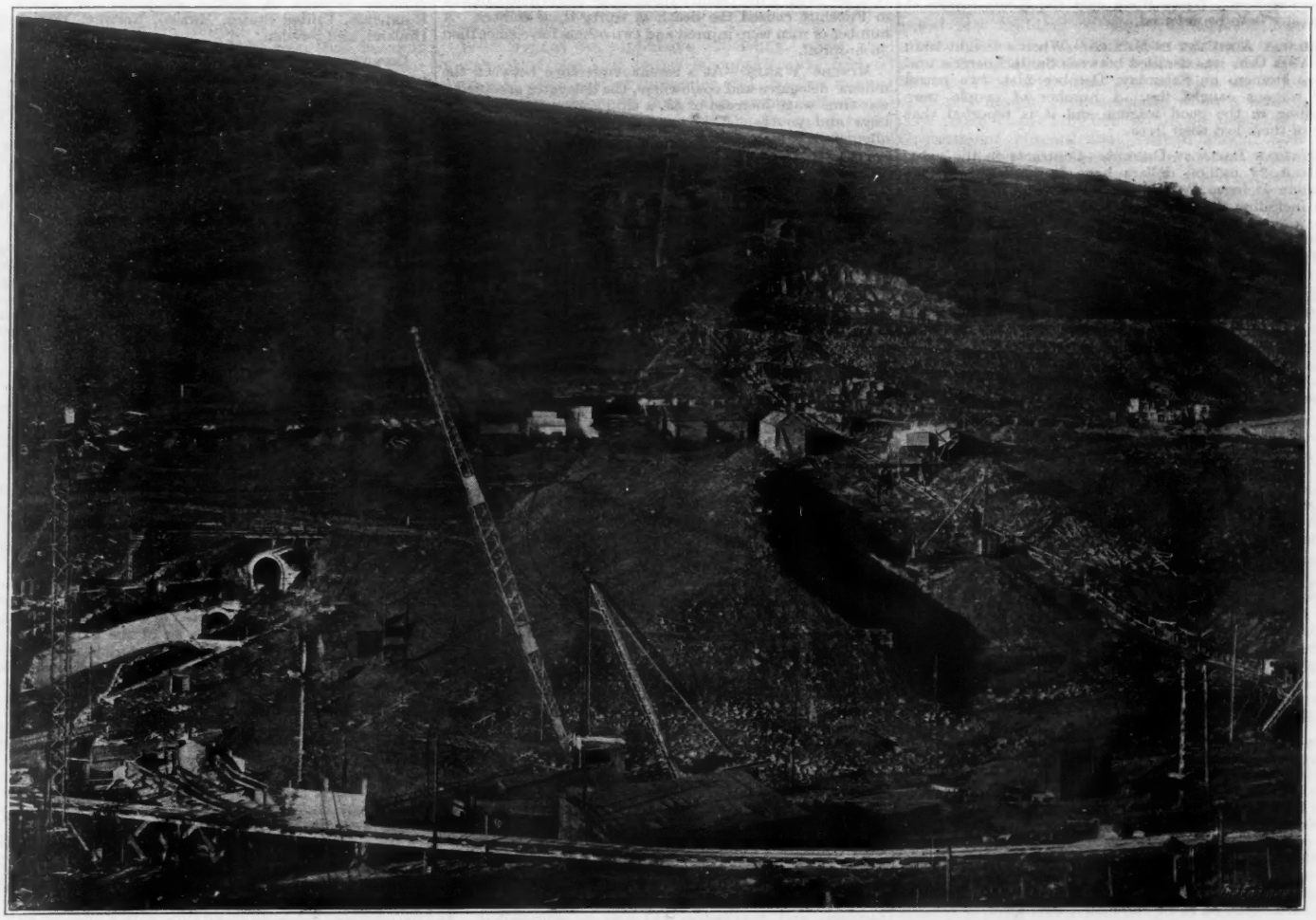
INSTITUTION OF NAVAL ARCHITECTS.—It is announced by the Institution of Naval Architects that until further notice no Meetings for the presentation and verbal discussion of papers will be held, and that only formal business will be transacted at the Annual General Meeting which falls to be held on Wednesday, March 13th, 1940. The Council will be pleased to consider papers on subjects relating to Naval Architecture or Marine Engineering. Such offers (or suggestions for papers on matters of interest to the Institution) should be sent in before the end of November. It is hoped to issue a list of papers in the Spring of 1940, and in due course advance copies of the papers would be available upon which written contributions would be invited. The Offices and Library will remain open at the home of the Institution, 10, Upper Belgrave Street, London, S.W.1, telephone Sloane 4622, and members who call or telephone are requested to do so between the hours of 10 a.m. and 4 p.m. from Monday to Friday. Books are still available on loan from the Library with certain exceptions.

LENINGRAD RIVER PORT.—In accordance with a scheme of reconstruction under the Third Five-Year Plan, Leningrad is to acquire one of the largest river ports in the world. The mooring front of the new port will be 7 miles long. In place of the dozens of different wharves, the port will be sectionalised into five large quays, where different categories of cargoes will be handled. For cargoes not handled at these regional quays twenty-two mechanised loading and unloading quays, and warehouses for the storage of goods for short periods will be built. The river port will provide for a considerable increase in passenger traffic. A big passenger station to be built on the Neva will be able to accommodate 1250 passengers. Every day a service of steam and motor-ships will sail to Lake Onega, the canals of Lake Ladoga, the Volkhov River, the White Sea Canal, and the Volga. An equal number of vessels will arrive daily at the station with passengers from Petrozavodsk, Povenets, Archangel, Novgorod, Gorky, Samara, and Astrakhan. Attached to the station will be the administrative offices of the river port. Services of motor-buses, trains, tramways, and trolley-buses will run to the port from all parts of the city. The new port will be completed in 1942.

LADYBOWER RESERVOIR, DERBYSHIRE

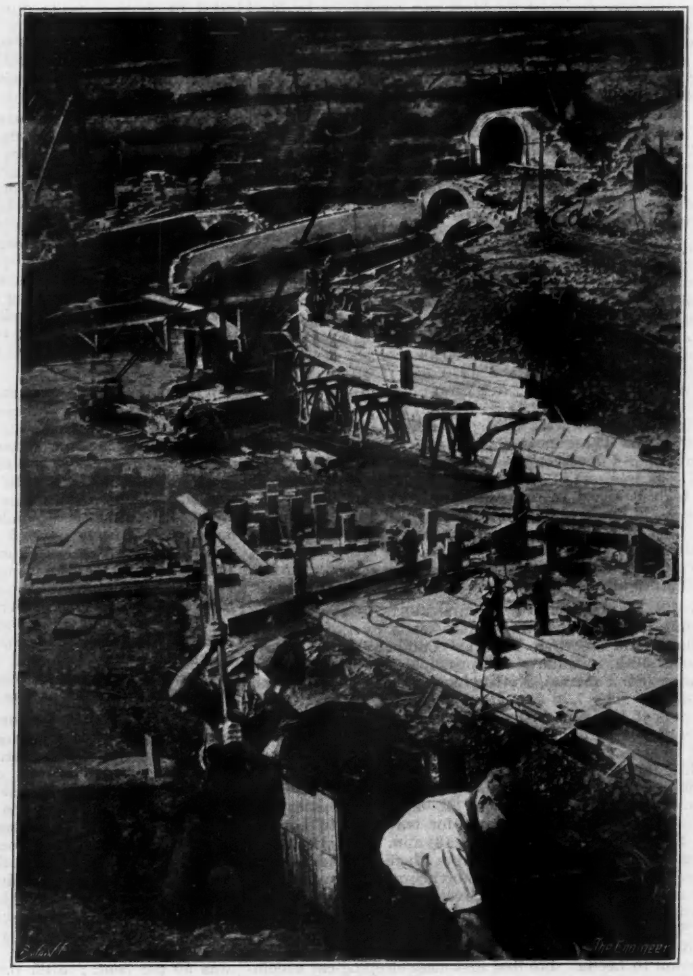
MR. H. P. HILL, MANCHESTER, CIVIL ENGINEER; MR. RICHARD BAILLIE, HADDINGTON, CONTRACTOR

(*For description see page* 440)



DAM UNDER CONSTRUCTION: VIEWED FROM SOUTH EAST

CUT-OFF TRENCH



TAIL-BAY WORKS

The Engineer

NOVEMBER 3, 1939

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*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

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SCIENCE AND PROPAGANDA

ONE of the reasons given by those who advocate the entrance of engineers and scientists into politics is that they are habituated by their training and by the bent of their minds to analyse phenomena and draw logical conclusions. Whilst this aptitude includes a devotion to truth, sufficient emphasis has, perhaps, not been laid upon that quality. In the pursuit of science it is the fundamental necessity, and in the practice of technology any attempt to shirk or burke or distort it brings its own revenge. It will be retorted by the captious critic that the scientist is as vague about the truth as Pilate. What he announces to-day as the truth, to-morrow he rescinds as a falsehood. That must be granted. Knowledge of few, if any, things is yet perfect and each new conquest may reveal some error in existing beliefs. But that is all to the credit of the genuine modern scientist. He puts all things to the test. Unlike his predecessors, he challenges authority. He is continually seeking for absolute truth and continually revising hypotheses in the light of new discoveries, no matter how high the authority upon which they rest. True, he opposes changes tooth and nail, but once he is convinced of his mistake he is as firm in his defence of the new as once he was in defence of the old.

This spirit knows no international boundaries. Revelation may come from any part of the known world and if it stands the keenest analysis it is accepted in every land. We have, perhaps, not reached that perfect state in which there is no rivalry between nations, no national bias towards one's own people. In this country we are exceptionally ready to acknowledge the work of foreign workers. That is rather characteristic of the British people who are somewhat prone to think more highly of doctors with foreign names than of their own specialists, and to be more susceptible to the charms of the Russian ballet if the performers, despite British nationality, are equipped with foreign patronymics. We have noticed that some other nations are less ready to attribute honour where it is due and that in their publications they are apt to overlook the work of foreign researchers whilst giving undue attention to their own. Whilst it is far from impossible that this bias is primarily due to ignorance, we have more than a suspicion that in these days when propaganda takes subtle forms, it is done with express purpose. The foreign reader who studies a text book on some subject with which he is not conversant and finds in it continual references to the work of, let us say, the Ruritanians receives the impression that Ruritania leads in that subject. Errors of that kind are eradicated only with the greatest difficulty. They become ingrained, just as the belief that German optical instrument makers are the best in the world is still firmly held in this country. So firmly held, indeed, that thousands of people will pay twice as much for German instruments as for British in the conviction that they are worth the price, forgetting that if they would make the same expenditure on home produced instruments they would get more value for their money. That result has been brought about by a long continued policy of self-praise—sometimes cast in a strictly scientific form and sometimes in a form to catch the public. In many instances the artistry of the advertisement is beyond praise. There is no slapstick about it, no boasting, but a simple statement of facts which is very persuasive and convincing. Too little attention has been paid to this art by British scientists and manufacturers. We are aware that a few firms do take the trouble to publish in the languages of the people for whom they are intended descriptions of their products, but there is, as far as we are informed, nothing approaching the regular practice of foreign companies. We are not refering to that old bone of contention the polyglot catalogue, but rather to bulletins and pamphlets written by technical people for technical readers. Many come to this office every year and command our respect. No doubt they are circulated widely, and their effect cannot be small.

If ever we have a Minister of Propaganda in this country, it will be not the least amongst his duties to see that, in the interest of overseas trade, publicity is given to British technical and scientific accomplishments. We can think of a dozen ways in which we are deficient, some of which like the displays made by Great Britain at foreign exhibitions and her relatively small interest in international conferences leap to the mind. But there are heaps of others, like lack of pertinacity, indolence, indifference, disinclination to spend money when a direct return is not visible, a readiness to employ foreign specialists when Britons could be found if encouragement were given them, and a tendency to pay more attention to foreign inventors than to our own. *Magna est veritas et prevalebit* is a magnificent assertion, but it does not cut much ice so long as the truth is kept under a bushel. In these days it is not sufficient to do things; you have to let the world know that you have done them. Self-praise only ceases to be a recommendation when it is blatant. It is often very necessary for the maintenance of a nation's prestige but it must be effected by constant calm pressure rather than by sporadic stunting. That is the kind of propaganda we have to face, and it can only be met by its kind.

Scrap Supplies for Steelworks

FROM time to time the British steel industry finds it necessary or advisable to institute a campaign to increase the domestic supplies of iron and steel scrap; and in doing so usually suggests that the community will be acting patriotically in helping the steelworks to maintain their outputs. There is more in this argument at the present juncture than in times of peace, and the thrust to secure supplies from domestic sources deserves success. On this occasion the Iron and Steel Control section of the Ministry of Supply is responsible for the campaign and it makes an appeal to all sections of the engineering industry—civil, mechanical, marine, aeronautical, and road and rail. It is pointed out that from the point of view of the steelmakers, scrap represents any kind of ferrous metal which can be re-melted and used in the manufacture of steel. Recently the quotations for scrap were brought under control and a schedule of maximum prices established. These, however, relate to the price which steelworks pay and bear no relation to the cost of scrap at its source, as transport and preparatory operations are necessary before the metal is delivered in suitable form to the steelworks. Mr. A. K. McCosh, Deputy Controller of Raw Materials at the Iron and Steel Control, points out that many factories and commercial premises contain such items as discarded machines, machine parts, old steel tools, shafts, broken pulleys, disused piping, metal sheeting, unwanted dies, jigs and old metal containers, all of which could now be put to national use. A special search, therefore, should be made of works premises and such material collected and disposed of forthwith to scrap iron merchants and dealers who would "arrange prompt collection." It is no secret that during recent weeks the steelmakers have not been satisfied with the quantities of scrap which have been available. Early in the year large tonnages were bought from the United States by the International Scrap Commission which acted for the steel industries in the European Steel Cartel. These purchases were divided and a good tonnage was allocated to Germany. It is understood, however, that deliveries to Great Britain have fallen into arrears and there is, therefore, a sound reason why an effort should be made to supplement supplies from domestic sources.

In an interesting review of the scrap trade, the Steel Control points out that the heavier types of scrap are re-melted with a proportion of pig iron in openhearth furnaces to produce acid and basic steel. Considerable tonnages, also, are used in electric furnaces. Light and miscellaneous material, normally baled, is sometimes charged into blast furnaces to increase the output of pig iron. Scrap cast iron is used almost exactly like pig iron in steel-melting shops and in foundries. Amongst the many commercial categories there is the "process" or "circulating" scrap produced by the steel industry itself as it works the cast steel ingot into the finished product; "new" or "producers'" scrap supplied in large tonnages by the iron and steel metal-working trades and the "obsolete" or "demolition" scrap produced by shipbreakers and dismantlers. The constant renewal of the country's industrial equipment is a prolific source of scrap material. This includes discarded machinery from factories, workshops and yards, and also the "refuse" or "destructor" scrap recovered by local authorities, who in some cases segregate the metal in their refuse before incineration. The latter category also includes the light and heterogeneous scrap collected by itinerant dealers from farms and dwelling-houses. Some districts are combed thoroughly by travelling junk merchants, but other areas are hardly touched in normal times because the value of the material so obtained cannot stand the high collection costs. An important part of the trade in "producers'" scrap is in the hands of merchants who often collect small quantities into sizable tonnages for delivery to the melting shops as

well as sort the collected material into the numerous grades suitable for the different requirements of the iron and steel industry. The review points out that the collection of light miscellaneous scrap is the most difficult because the available deposits are small, scattered, and of uncertain quality. The importance of scrap to the steel industry is shown by the fact that in 1937, a representative year, about seven and a half million tons were melted in manufacturing the 13,000,000 tons of steel ingots produced in this country. Some 2,850,000 tons of scrap steel and 226,000 tons of cast iron scrap were supplied by the steelworks and about 4,034,000 tons of scrap steel and 367,000 tons of cast iron scrap were bought from outside sources. It is calculated that the turnover of purchased scrap would be about £13,000,000 per annum.

Although the review does not mention the fact, the scrap which arises in the course of engineering works' operations forms a useful and often profitable by-product, and there is a natural tendency to delay its disposal until the market is favourable to the seller. On the other hand, the buyer is apt to regard scrap as material which, since it cannot be used in the producers' own works, should be sold cheaply as at the present time it is to the national interests that it should be made into new steel. Rightly or wrongly, the view is held that some of those industries producing scrap in considerable quantities have been waiting in the hope of obtaining more remunerative terms than are now being offered. It would be difficult to say how much truth there is in this assumption, although there is no doubt that many firms believe that they are not receiving satisfactory prices for their scrap. The steelmakers and the scrap merchants have reached a collective understanding regarding prices and supplies, and the need for some similar agreement seems to be indicated between the engineering industry and the steel trade. The proportion of scrap used in furnace charges varies from time to time and from district to district in accordance with the convenience of bulk scrap supplies, local steelmaking practice, and the relative price of scrap and pig iron. Naturally this has a bearing on local prices, which vary to some extent. Previous to 1914 the average percentage of scrap used in the British steel trade was about 30 per cent. and in some areas as low as 10 per cent. During the last war the proportion was increased to about 60 per cent. and it remained at this level during the greater part of the post-war period. Present-day practice varies from about 75 per cent. in Sheffield to around 25 per cent. in Lincolnshire. The latter district purchases little if any scrap but uses its own process waste. Recently there has been a movement towards the greater use of pig iron. As the Steel Control points out, as much home material as possible should be salvaged and used from sources not thoroughly "tapped" in ordinary circumstances in order to avoid dependence upon foreign imports, reduce the risk of sea transport, and save on foreign exchange.

Obituary

DR. RICHARD VERNON WHEELER

It is with deep regret that we record the death of Dr. Richard Vernon Wheeler, Professor of Fuel Technology at the University of Sheffield, which took place at his home, Stumperlowe Mansions, Sheffield, on Saturday, October 28th, at the age of 56. Dr. Wheeler was closely associated with the experimental work on safety in mines, and was Director of the Safety in Mines Research Stations at Sheffield and Buxton. He will long be remembered for the original work he was able to carry out in demonstrating the explosion of gases under conditions corresponding closely to those observed in coal mines. He was born in January, 1883, and was the son of the late Mr. R. J. Wheeler who was Chief Inspector in the Royal Navy. After receiving his early education at Plymouth College he proceeded to Owen's College, Manchester, where he had an outstanding academic career, and became Dalton Scholar and a Fellow of Manchester University. After leaving the University, Dr. Wheeler occupied a number of positions in connection with the chemical side of the gas industry. These included that of chemist and gas works manager to Monks Hall and Co., Ltd., of Warrington; chemist to the British Coal Dust Experiments Committee of the Mining Association of Great Britain; chief chemist to the Explosions in Mines Committee of the Home Office, and testing officer to the Mines Department of the Board of Trade. Alongside his scientific work, Dr. Wheeler found time to associate himself with the work of several scientific and technical institutions which included among others, the Iron and Steel Institute, the Institution of Mining Engineers, the Institution of Petroleum Technologists, the Institute of Fuel, and the American Institute of Mining and Metallurgical Engineers. He was a member of the Committee on Miners' Lamps, the Safety in Mines Research Board, and the Explosives in Mines Research Committee. On the Fuel Research Board, Dr. Wheeler served from 1924 until 1929, and from that year till 1930 he was a member of the Gas Poisoning Committee which was appointed by the Board of Trade. Dr. Wheeler was also a past president of the Midland Institute of Mining Engineers. He was a Fellow of the Geological Society, the Institute of Chemistry, and the Chemical Society. His death at a comparatively early age will be felt keenly in the wide circle of chemical, fuel technological, and mining activities, in which his work was so well known.

Literature

Route Surveys. By H. Rubey. New York: The Macmillan Company. Price 16s.

This well-bound little pocket-book of about 550 pages is divided into two approximately equal parts, the first describing the preliminary survey, location and some aspects of the construction and maintenance of railways and other routes, and the second providing the appropriate mathematical tables.

The Surveying Teachers' Conference of the Society for the Promotion of Engineering Education suggested in 1937 that problems of route location, curve lay-out, measurement, computation and lay-out of earthwork, should be treated as elements applicable to many forms of engineering work, such as highways, canals, pipe lines and transmission lines equally as much as to railroad construction, and this pocket-book has been written from this point of view.

Some of the subject matter will appear strange to engineers with home experience only, but not to those with experience in the newer countries abroad, where there are no ordnance surveys and contour maps to facilitate the preliminary lay-out. So after a brief introductory chapter the author commences with "The Reconnaissance" and discusses the influence of typography, physical and political controlling points, limiting gradients and curves, and the obtaining of elevations with the aneroid barometer. The chapter on the preliminary survey is a statement of the operations to be carried out in the standard type of preliminary and in the stadia preliminary, rather than a description of these operations, but examples of the field books are given. The very brief chapter on the location survey refers to grade contours, balanced cut and fell, and some typical examples of location maps and profiles are reproduced. The following seven chapters relate to curves of various kinds, simple circular curves, compound and reverse curves, curve problems solved by traverse, vertical and other parabolic curves, transition curves, railway turnouts, and string lining of curves. Circular curves are defined by the angle subtended at the centre by a 100ft. chord, but in the final chapter in the first portion of the book formulæ are given for the arc definition of degree of curvature in which a 100ft. arc is substituted for the 100ft. chord. Apparently both systems are in use in the United States of America.

After curves come volumes of excavation and embankment, including the prismoidal formula and correction for curvature. This chapter on earthwork measurement is followed by another entitled "Haul and Mass Diagram." In modern railway construction in this country there are generally so many road crossings that the whole line has to be constructed on bank or in cutting to facilitate the arrangement of the out-of-level crossings, and the important consideration is to balance the cut against the fill. In newer countries where the cost of land is not so prohibitive, it is often more economical to obtain earth for the embankments from borrow pits alongside, rather than haul it from the nearest cutting, and the object of the haul and mass diagram, used in conjunction with the contractor's prices for excavation including a certain distance of free haul, and for overhaul, is to determine which is the more economical method of construction.

A very brief legal chapter on rights of way is followed by a long one on construction, divided into two parts—procedure and data. Procedure includes setting out works, forms of contract, partial and final estimates of cost, and progress reports. Data include bearing pressures on foundations, bearing capacity of piles, strength of materials, concrete data, flow of water in pipes and open channels and over weirs, conversion tables and weights of materials. The final chapters of the first half of the book, which, by the way, is illustrated with about 150 diagrams, relate to astronomical observations in survey work, the adjustment of instruments and arc definition of degree of curvature to which reference has already been made. In an appendix about 80 problems are set, grouped under the numbers of the chapters to which they apply.

In the second half of the volume there are thirty-four different tables. The first of these applies to circular curves varying from 0 deg. to 60 deg. and gives the deflection angle, the radius, the logarithm of the radius, the tangent off-set for a 100ft. chord, and the mid-ordinate for a 100ft. chord for the chord definition of degree of curvature, and the radius and chord for the arc definition. Table II gives the lengths of circular curves and tangents, and the external distance from the centre of the curve to the intersection of the tangents, for 1 deg. curve subtending angles varying from 0 deg. to 93 deg. at one-minute intervals, and a formula for obtaining approximate values for any other degree of curvature, while Table III gives corrections to be applied to obtain exact values. There are six tables referring to the American Railway Engineering Association standard 10-chord spiral, in which the degree of curvature varies with the distance from the origin, logically followed by a table of theoretical or balanced superelevations for various velocities and degrees of curvature.

Next come five-figure logarithms of numbers and trigonometric functions followed by five-figure values of the trigonometric functions, powers, roots, and reciprocals. These are the Macmillan Mathematical Tables specially reduced to pocket size for this volume. The five figure logarithms are well chosen for a book of this nature and give just the degree of accuracy required for ordinary surveying work. Six tables give earthwork quantities for normal sections, but one of these, a folding diagram giving cubic yardage for triangular prisms, has been wrongly bound up to face page 232 of the first portion of the book instead of this page of the second portion. Two tables give leads, ordinates and other dimensions for railway turnouts, and a third the middle ordinates for bending rails. Among the remaining tables are stadia coefficients, grades and grade angles, average air temperature correction for barometric levelling, and trigonometric formulæ for the solution of plane triangles.

This is undoubtedly a very useful pocket-book and the most striking feature is that it differs from most works on surveying. It does not teach how to survey, but it does remind the reader of what will be required to undertake such work, and efficiently supplies useful data to carry it out.

BOOKS RECEIVED

Fire. By Major C. C. B. Morris, C.B.E. London: Blackie and Son, Ltd., 50, Old Bailey, E.C.4. Price 12s. 6d. net.

Heat Power. Second Edition. By E. B. Norris and E. Therkelsen. London: McGraw Hill Publishing Co., Ltd., Aldwych House, W.C.2. Price 24s. net.

A First Course in Mathematics for Technical Students. By P. J. Haler, M.B.E., M.Sc., and A. H. Stuart, Ph.D. London: University Tutorial Press, Ltd., Clifton House, Euston Road, N.W.1. Price 3s. net.

Guide to the Unemployment Insurance Acts. Fifth Edition. By H. C. Emmerson, M.A., and E. C. P. Lascelles, O.B.E. London: Longmans Green and Co., Ltd., 39, Paternoster Row, E.C.4. Price 6s. net.

Report on Occupancy Tests of Air Raid Shelters for Factory Workers at the Works of J. and E. Hall, Ltd., Dartford, Kent. London: H. K. Lewis and Co., Ltd., 136, Gower Street, W.C.1. Price 2s. net.

Ninth Report on the Heterogeneity of Steel Ingots. Report by a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council. London: Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1. Price 10s. net.; to members 5s. net.

Projected Exhibits at Olympia

No. VIII

(*Continued from page 433, Oct. 27th*)

BELOW we continue our description of some of the exhibits which were to have been shown at the Engineering and Marine Exhibition at Olympia, London, the holding of which has had to be postponed on account of the war.

Sharples Centrifuges,, Ltd.

The intended exhibits of Sharples Centrifuges Ltd., of Sharples House, 101, Grosvenor Road, London, S.W.1., were several types and sizes of the firm's separators and clarifiers and a self-discharging horizontal bulk centrifuge. These machines were to have been shown in operation. Types are made suitable for the purification of fuel and lubricating oils, the dehydration of water gas tar emulsions, the clarification of enamels and varnishes, the treatment of paper works effluent, sewage sludge, starch liquors, and many other purposes. One of the most general applications of the firm's "Super-Centrifuge" machines is on board ship for the purification of fuel and lubricating oils in the case of motor vessels, and for turbine lubricating oils in the case of steam turbine driven vessels.

It is claimed that the "Super-Centrifuge" develops a very high effective centrifugal force, amounting to 13,200 times that of gravity, obtained by revolving the bowl at 15,000 r.p.m. These machines have been described previously in these columns on the occasion of former Olympia Exhibitions. It will be recalled that they are of simple design and are constructed so as to require the minimum of attention in operation and maintenance.

A machine which we have not previously described in detail is the firm's horizontal bulk centrifuge, which is widely used by chemical manufacturers. The machine which was to have been exhibited has a basket 20in. in diameter. Its construction and design can be followed from the accompanying sectional view and photograph reproduced in Figs. 177 and 178 respectively. It is eminently suitable for drying ammonium sulphate and many other crystalline materials.

Referring to the drawing, the bed casting A, of cast iron, supports a housing B for the rotor, made of non-corrosive material. Since the machine is relatively small, it has been possible to build it of non-corrosive metals. For use with ammonium sulphate dense centrifugally cast aluminium bronze is employed for the rotor, and the housing is solid bronze. In fact, all parts of the machine in contact with liquor are of non-corrosive material, and no lead coverings are necessary or used. The rotor C is weldless in construction, and is sufficiently thick not to require retaining bands. Because of its dense character, as a result of being centrifugally cast, corrosion is claimed to be minimised and its machined surfaces are said to appear as non-porous as though constructed of forged steel. It is lined with a single endless band of stainless steel screening D of unusual weave. Grooving on the interior surface of the rotor permits efficient drainage without the use of a backing screen. This construction, we are informed, gives a true-running screen surface, an advantage which enables the removal of cake at each cycle to be almost complete, thus providing in effect a fresh, free-draining filter bed after each unloading. The front, or lip ring, E, of the rotor is removable, facilitating the removal and replacement of screens; the cylindrical screen can be slipped straight into the basket, and there is no need for sewing it to the basket shell. Furthermore, there is no bearing or shaft in front of the rotor to complicate the work of opening the housing and replacing the screen.

A stellited unloader knife F is arranged to be hydraulically operated, with a radial movement into the basket so as to remove the entire crystal layer in one slow stroke, the dried crystals passing down the chute G. At H is indicated a floating cake-levelling arm, or crystal distributor, which rides on the surface of the material in the rotor. This component has two functions; firstly, to level the cake in the rotor while the material is feeding in, thereby promoting smooth operation by giving a well-balanced load, and also increasing the effective feeding rate; secondly, by means of a pivoting action as the load increases, it turns off the feed valve when the rotor is fully loaded.

The feed valve J consists of an air-operated diaphragm of simple construction, and a small quantity of compressed air at 30 lb. per square inch pressure is required for its operation. It is designed to permit substantially streamline flow of slurry; no pockets exist in which crystals can accumulate and obstruct its operation. It is fitted with a cover plate which can be removed easily for the inspection or replacement of the valve disc and valve seat. The valve is packed for service with corrosive liquids and is provided with pressure lubrication to protect the stem and packing.

For operating the hydraulic unloading mechanism, an oil pump K and an oil reservoir integral with the bed casting are arranged, the pump being driven through gearing L from the centrifugal shaft. Since the oil reservoir and oil pump are built into the bed, the hydraulic system is completely self-contained. Oil flow to the hydraulic unloader is controlled by automatic timing mechanism, which can be set to give such duration to the cycle as may be desired. At M is indicated the unloader control cylinder for actuating the unloading knife; N is the limit switch. At P is the effluent discharge.

The usual cycle of operations consists of feeding a slurry of crystals and liquor to the machine, rinsing with water, whirling to the desired dryness, and unloading the dried salt from the basket. All these operations occur without the necessity of slowing down the rotor, and in the case of ammonium sulphate, the cycle, we are informed, requires approximately 45 seconds. The drying period, as explained above, can be lengthened or shortened by a simple adjustment of the automatic timing mechanism in case a change in the dryness of the final product is desired. The timing of the rinse is likewise readily controllable, and once set, uniformity of operation is ensured and cannot be subject to an operator's error.

The basket is designed to hold 1 cubic foot of cake, equivalent to 50 lb. of ammonium sulphate crystals, and the normal hourly capacity is stated to be about 2 tons of product when the machine is set to operate on a 45-second cycle. With especially free-draining crystals, a shorter cycle is adequate and a higher hourly capacity results. With normal ammonium sulphate crystals, it is claimed that less than 2 per cent. moisture and less than 0·15 per cent. acid remains. The machine is stated to be particularly suitable for free-draining crystals such as table-salt, urea, copperas, ammonium sulphate, etc., for the advantage of automatic control gear is more apparent when a material which can be frequently unloaded is being handled.

The machine can be mounted on a small foundation, consisting of a 2 cubic yard concrete base. It is driven at 1750 r.p.m. by a 20 H.P. motor with normal torque and low-starting current characteristics. Either direct coupling or V-belts can be used for the drive, and, when operating at 2 tons

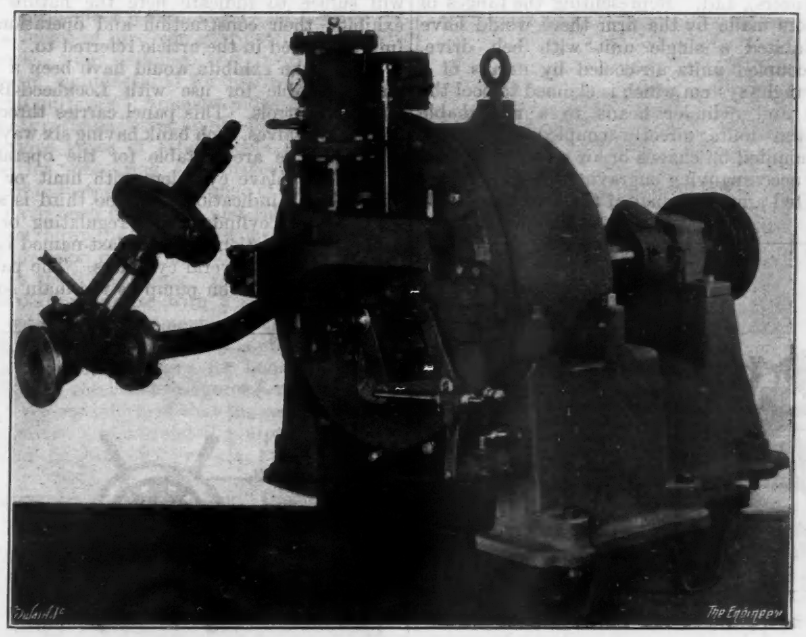


FIG. 178—HORIZONTAL BULK CENTRIFUGE—SHARPLES

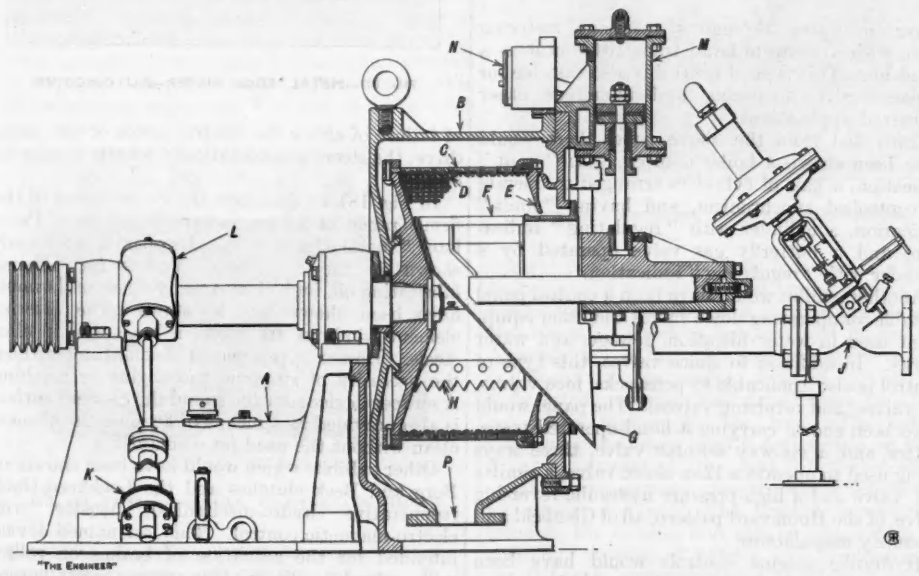


FIG. 177—SECTION OF HORIZONTAL CENTRIFUGE—SHARPLES

per hour output, the actual motor load is stated to be 12 kW.

Slurry is usually arranged to be fed from a tank 6 to 7ft. in diameter mounted above the machine and as close to it as is practicable. This tank should be made with a conical bottom having a 2in. outlet and a 30 deg. inclination from the vertical, with the outlet not less than 5ft. above the machine floor level.

H.E.C. Compressors and Engines, Ltd.

A number of small air compressors having capacities from 2 to 15 cubic feet per minute would have been shown by H.E.C. Compressors and Engines, Ltd., of 234, Pentonville Road, King's Cross, London, N.1., on the stand to have been taken by the associated company, Hancock and Co. (Engineers), Ltd. Representing the ranges of compressors made by the firm there would have been exhibited a single unit with belt drive, directly coupled units air-cooled by means of a forced draught system which is claimed to cool the cylinders and cylinder heads to a remarkable degree, and units directly coupled to electric motors mounted on chassis or air receivers.

In the accompanying engraving, Fig. 179, there is illustrated a new product of the firm, a portable

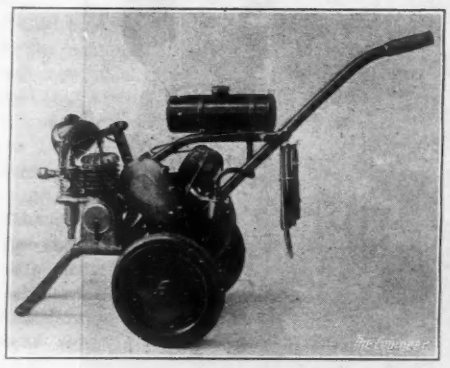


FIG. 179—PORTABLE AIR COMPRESSOR—H.E.C.

engine-driven compressor unit, suitable for supplying compressed air for tyre inflation or other purposes. The unit is strongly built to withstand the rough usage to which this type of equipment is frequently subjected. A heavy-gauge steel frame carries the engine and compressor and is supported on solid rubber-tyred disc wheels 12in. in diameter. So that the unit can be readily handled, the components are arranged to be well balanced about the axle.

The compressor is designed for a capacity of 2½ cubic feet per minute. Radiation fins for cooling are cast on the cylinder which is made from cast iron. The crankcase is cast aluminium and fitted with a detachable end cover and a breather. Cooling is assisted by directing air on to the cylinder from the crankcase breather. Two large-diameter ball bearings are used to support a counterbalanced crankshaft, and a ball bearing is arranged for the big end of the connecting rod. The small end is provided with a phosphor bronze bush. Machined from an aluminium die casting, the piston is ground to give a minimum clearance, and is provided with two compression rings and a scraper ring at the bottom of the skirt. Contained within a mild steel housing, the valve gear comprises stainless steel flat automatic inlet and exhaust valves; air is drawn through a felt ring which acts as a cleaner and silencer. The full diameter ring inlet and plate delivery valves are claimed to be efficient and to be designed for pressures up to 150 lb. per square inch. The cylinder head is of mild steel and is provided with a finned aluminium cover to assist cooling; it screws on to the cylinder and retains the valve housing in position. Lubrication is by splash, oil being conducted to the bearings by ducts in the crankcase; a baffle plate is fitted to the mouth of the cylinder to prevent over-lubrication. An aftercooler and separator are provided.

The petrol engine for driving the compressor is of H.E.C. manufacture and works on the two-stroke cycle. It is provided with Miller flywheel ignition, and drives, in addition to the compressor, a small generator, the current provided being available for a spot light, which can be seen mounted at the front of the chassis. Approximately 1 H.P. is developed by the engine, which is started by means of a handle, and is provided with a manual throttle control to the carburettor for speed regulation. The drive, totally enclosed, is taken by a chain to a countershaft, and thence the final drive to the compressor is by a chain to a sprocket on the flywheel, which also carries a permanently fixed starting-handle attachment. Mounted above the engine is a tank containing sufficient fuel for 4 to 5 hours' continuous running. The equipment is completed by a pressure relief valve which can be pre-set for any pressure up to 150 lb. per square inch, and a length of high-pressure hose.

Automotive Products Company, Ltd.

The main exhibits to have been shown by the Automotive Products Company, Ltd., would have been Lockheed hydraulic industrial and marine controls, and the Lockheed-Babcock system of boiler damper controls. We hope to describe in a future article the system in detail, and therefore it will suffice to indicate here the nature of the exhibits, their construction and operation being fully discussed in the article referred to.

One of the exhibits would have been a control panel suitable for use with Lockheed-Babcock damper controls. This panel carries three banks of selector valves, each bank having six ways. Two of the banks are suitable for the operation of "Autoloc" slave cylinders with limit or "open and closed" indication, and the third is suitable for operating cylinders with regulating or "continuous" indication. In the last-named case one indicator serves several cylinders. The panel has an electrically-driven pump as the main source of

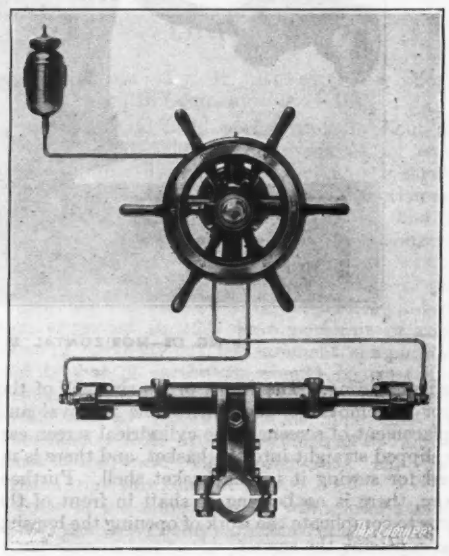


FIG. 180—STEERING GEAR—AUTOMOTIVE

power, operating through a reversing metering valve with a separate hand transmitter unit as a stand-by. This type of control is also suitable for furnace valve operation, and numerous other industrial applications.

Controlled from the above panel there would have been shown a boiler damper, with "limit" indication, a pair of cylinders arranged to operate in controlled synchronism, and having "limit" indication, a cylinder with "regulating" indication, and a butterfly gas valve operated by a cylinder with "regulating" indication.

Another exhibit would have been a control panel suitable for operating sluice valves and other equipment used in water filtration, sewage, and water works. In addition to sluice valves, this type of control is also applicable to penstocks, face valves, air valves, and reversing valves. The panel would have been shown carrying a hand-operated transmitter and a six-way selector valve, three ways being used to operate a 12in. sluice valve, a similar 6in. valve and a high-pressure hydraulic reversing valve, of the Homeyard pattern, all of Glenfield and Kennedy manufacture.

Hydraulic marine controls would have been represented by six exhibits. One would have been a combined Lockheed reverse gear and throttle control, fitted to a Perkins 100 H.P. oil engine. The control operates in conjunction with a single pipe line throttle or fuel pump control, and is so arranged that the throttle or fuel pump is automatically closed before a gear change can be made, although at other times the action is entirely independent of the reverse gear control.

The firm's wheel type throttle control is a small hydraulic installation suitable for the remote operation of carburettor or ignition on petrol and paraffin engines. A single pipe line only is required, and it is claimed that distances up to 60ft. can be readily accommodated; one turn of the hand wheel moves the operating piston through its full stroke of 1in., and the unit is self-locking in any position. Another pattern of throttle control made by the firm is a lever-operated mechanism. It is a double pipe line control and is stated to have a maximum torque of 250in. lb. in either direction.

In Fig. 180 is shown a layout for the firm's hand-operated steering gear. This unit is described as being of the reactive non-servo type, and consists of a four-cylinder rotary transmitter operated directly by the steering-wheel and connected by two pipe lines to the tiller-operating cylinder. A servo-hydraulic steering mechanism is also made for applying large efforts or for use when a light control is desired. The hydraulic power is supplied by a pump which can be driven either by an electric motor or directly from one of the main engines. The fluid delivered from the pump passes through two control valves and operates the tiller cylinder. The pump only exerts pressure when moving the rudder stock; at all other times it is on an open circuit and not blowing off against a spring-loaded valve. Three sizes of steering gear are manufactured, giving torques of 29,000, 62,000, and 100,000in. lb. at the rudder stock. In the event

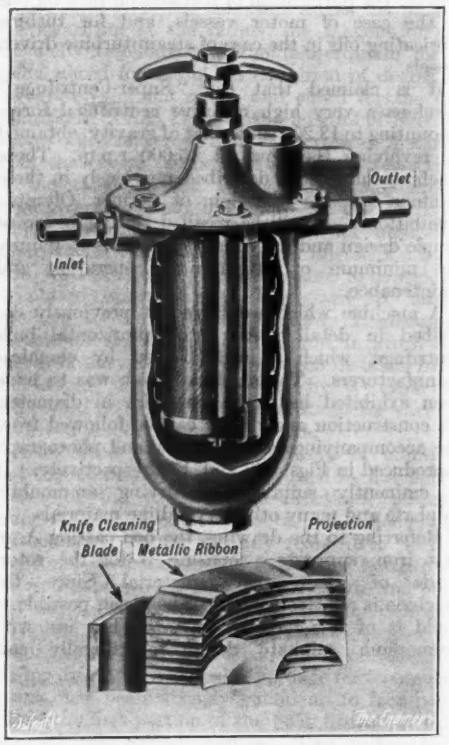


FIG. 181—METAL EDGE FILTER—AUTOMOTIVE

of failure of either the electric motor or the pump drive, the steering automatically reverts to manual control.

In Fig. 181 we illustrate the construction of the firm's range of filters, incorporating the "Purolator" metal edge system. Its operation is clearly shown in the engraving. Models for filtering lubricating oil, fuel oil, and many other fluids would have been shown on the stand. The filtering element windings are made in brass and in alloy steels. Duplex types permit dismantling without the necessity of stopping the engine or machine. A scraper device rotating round the element surface is also provided as a means of keeping the element clean without the need for dismantling.

Other exhibits which would have been shown are Borg and Beck clutches and the Lockheed-Gates regenerative hydro-mechanical booster with electro-magnetic control. This last-named device, intended for the actuation of brakes on rolling mills, calender mills, printing presses, hoists, cranes, and so forth, was fully described in The Engineer of June 2nd, 1939. A large brake effort combined with light weight and low cost, and the ease with which it can be either hydraulically or magnetically controlled, are claimed to be the main features of this apparatus.

J. Dampney and Co., Ltd.

On the stand which would have been taken at the Exhibition by J. Dampney and Co., Ltd., of Britannic Works, Newcastle-upon-Tyne, would have been shown a small glass model boiler to demonstrate the use of a coating of a product

known as "Apexior" on the internal surfaces of boilers, economisers, and steam plant generally. The product is a protective coating for metal surfaces, claimed to prevent oxidisation and improve heat transference properties. In the model a short section of 1½in. outside diameter steel boiler tube is enclosed within a glass jar, with water on the exterior surface, and heat, supplied electrically, on the inside. The bubble formation is therefore visible. The condition of the tube is said to have a considerable effect on the bubble formation. An identical arrangement, with the exception that the boiler tube is coated with "Apexior," is arranged alongside. Heat in each case is supplied by cartridge elements, and the tubes are closed at the bottom by brass discs.

The demonstration would have shown that in the case of the coated tube the bubbles are small and evenly distributed. Furthermore, no discolouration of the water takes place with the coated tube, whereas with the uncoated tube the water discolours immediately by reason of the formation of iron oxide. Improved heat transfer on the coated tube is noticeable if the heating elements are withdrawn to the top of the tubes and reintroduced. The path of the bubble formation as the elements drop to the bottoms of the tubes shows a time lag in favour of the coated tube, the bubbles reappearing more quickly. This result is attributed to the increased "wet-ability" of the coated surface.

For applying the compound to steam-raising plant, the firm would have shown compressed air and electrically operated equipment known as Dampney "Powercoater" equipment. The apparatus is driven through flexible shafts and is designed to inject and spread the "Apexior" compound on the internal surfaces of the tubes at the time of the routine boiler cleaning and maintenance operation. We are informed that less than one minute is required for treating each tube. The "Powercoater" is revolved by means of the tube cleaner, during the coating process, at a speed considerably less than that of the cutting head used in removing boiler scale. Bristle brush units expand by centrifugal force and press against the tubes, brushing a uniform coating of the product into the pores of the metal. The brush units are designed to accommodate themselves to any tube curvature or irregularity and are made in a number of types and sizes, suitable for usual sizes and shapes of boiler and economiser tubes.

Short and Mason, Ltd.

A varied range of industrial and scientific instruments for marine and general use would have been shown by Short and Mason, Ltd., of Aneroid Works, London, E.17. One of the most interesting of the firm's developments is a new type of time schedule controller, so called because it controls temperature, pressure rate of flow, liquid level, etc., to a given schedule, continuously repeating the schedule as required. The instrument, illustrated in the accompanying engraving, Fig. 182, is designed to

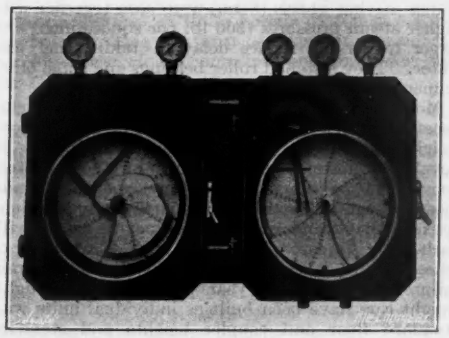


FIG. 182—TIME SCHEDULE CONTROLLER—SHORT

operate in conjunction with the usual types of diaphragm valves and similar devices. It is housed in two casings, the left-hand casing containing a cam mechanism, and the right hand a controlling and recording portion. The curvatures of the cam dictate the temperature and pressure cycle through the recording and controlling mechanism. Compressed air is the actuating medium. Of interest is a quick-rise mechanism which is claimed to enable almost any rate of rise to be obtained, and an adjustment termed a "universal sensitivity adjuster," for matching the instrument sensitivity with the time lag of the apparatus controlled, so that a close "throttling" control is effected.

Another new production which would have been shown is a range of dial thermometers, mercury and vapour actuated, in brass chromium-plated cases, furnished with 6in. diameter dials. The mechanism is similar to that fitted in the firm's 8in. instruments, and there is a bold pointer moving over easily read graduations. A heat-treated alloy steel movement can be supplied if the instrument is required to withstand much vibration. For use in fluctuating temperature zones with these instruments the firm makes temperature-compensated capillary tubing, known as "Accuratus" capillary tubing.

Thomas Mercer.

On the stand which would have been taken by Thomas Mercer of St. Albans, there would have been exhibited a range of chronometers, master clocks, and control panels, chiefly for marine use, and specimens of precision gear cutting, recording clockworks, time switches, and various types of mechanism manufactured for marine and general industrial purposes. Amongst industrial engineers the firm is perhaps better known for its dial gauges and various types of attachments making them suitable for measuring and inspecting in every branch of industry. A full range of such products would have been displayed, and there would also have been shown the firm's latest development in the field of precision measuring, namely, an instrument known as the "Precimeter" reading in 0·001 mm. or 0·00005in. complete with a specially designed stand with the refinements necessary for fine checking. Other exhibits of this character would have been cylinder gauges for bores of ¼in. and upwards, and the latest design of Lindley extensometer. We are informed that the sole distributors for dial gauges and associated equipment are J. E. Baty and Co., of 39, Victoria Street, London, S.W.1.

We illustrate in Fig. 183 the "Precimeter," an

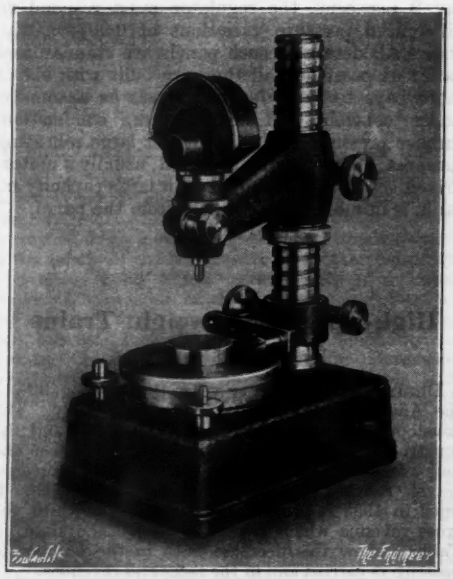


FIG. 183—PRECISION COMPARATOR—MERCER

upright precision comparator incorporating a dial indicator and capable of fine measurements. To the base of the instrument is fitted a 4in. diameter circular table which is grooved and lapped flat. A central hob in the table enables anyone of three additional interchangeable anvils of various sizes to be fitted; they are held firmly down by a locking screw underneath the base. The column supporting the gauge head is designed to be rigid; it has a diameter of 2⅛in., and is provided with a spiral groove giving a coarse vertical adjustment by means of a nut. The bracket is accurately fitted to the column and can be clamped in any position. A range of 0·004in. can be obtained on the dial scale, and readings of 0·00005in., or alternative, 0·001 mm. can be made, the graduations being on either side of the zero mark. A fine adjusting screw is provided, also a lifting lever and a detachable sapphire contact point.

In Figs. 184 and 185 the Lindley extensometer is illustrated; the model shown mounted on strip material under test on the tensile testing machine is an instrument with a 3in. gauge length. By cranking the arms, the instrument can be made for measuring on a 2in. gauge length, as shown in Fig. 184. The accuracy and sensitivity is claimed fully to comply with B.S.I. and A.I.D. requirements. The magnification factor is 1250 to 1 and specimens up to ⅝in. diameter or thickness, and ¾in. wide can be accommodated. It is claimed that the instrument, although simple and practical, is nevertheless capable of accurately measuring extensions to plus or minus one twenty-thousandth of an inch, whilst alterations to the length of the specimen of the order of one hundred-thousandth of an inch are clearly indicated. These figures are considered to be sufficient for all practical purposes, even with a gauge length as short as 2in., and in fact, the degree of accuracy to which the extension is measured is said to be greater than the accuracy with which the load applied or the area of the specimen can be gauged in ordinary circumstances.

The principle on which the extensometer works is simple. The extension of the material under

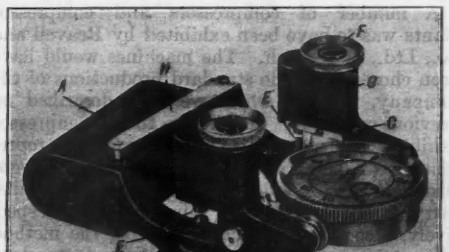


FIG. 184—LINDLEY EXTENSOMETER—MERCER

test in an ordinary tensile testing machine is magnified in the ratio of 2 to 1 by a single lever, and thereafter measured and indicated by a Mercer dial gauge graduated in ten-thousandths of an inch. A movement of the dial finger over one division indicates therefore an alteration in the length of the specimen of one twenty-thousandth of an inch. Advantages claimed in the design are that the instrument is always in static balance about the axis of the test piece, so that errors by reason of bending stresses caused by the weight of the extensometer on the test piece are eliminated; that minute distortions inevitably set up in the instrument whilst gripping and straining sheet and strip materials do not affect the dial reading; and that frictional lag, hitherto practically inseparable from mechanical extensometers, has been almost entirely eliminated.

Referring to Fig. 184, the extensometer consists of a body A having a rigid arm B. To the upper

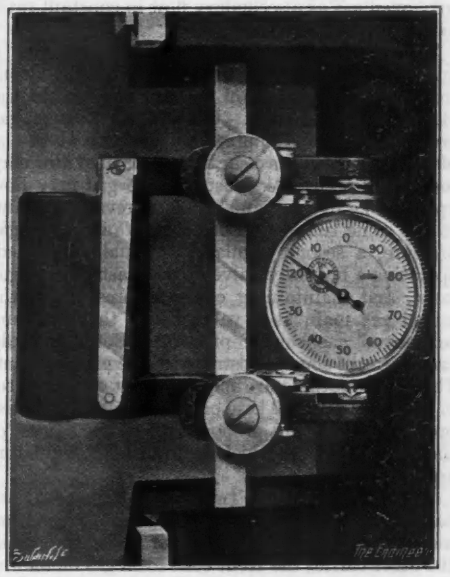


FIG. 185—EXTENSOMETER ON TEST PIECE

end of the column is hinged a similar arm C, the hinge consisting of a wide strip of spring steel, which allows the arm to move in a vertical plane whilst preventing any sideways or rotational movement. The specimen is gripped between the ends of the screws E, which are operated by means of thumb wheels F through gears housed in casings G in such a manner that the vertical axis of the specimen, whatever may be its thickness, is always coincident with the central plane of the extensometer. To the upper arm is secured a spring steel lever H which passes down the front of the body and carries a cone-shaped button. Pressure on the lever forces the cone into a hole at the base

of the column and it is so arranged that when this action takes place the distance between the axes of the gripping screws is 2in. The outer end of each arm is provided with a hardened steel bush recessed to take one of the ball ends with which a specially modified dial gauge is fitted. The ends are retained in the sockets by means of forked springs which prevent end play but permit the dial to be rotated into a position convenient for observation. In the event of the test piece elongating unduly or breaking, the dial is released without damage, and although the spring hinge may be strained, the consequences are not serious, for this part can be readily removed for correction or replacement.

Reavell and Co., Ltd.

A number of compressors and compressor plants was to have been exhibited by Reavell and Co., Ltd., of Ipswich. The machines would have been chosen from the standard productions of the company, most of which we have described on previous occasions. In addition to the compressor exhibits, the firm was also intending to show representative examples of the Reavell-Askania regulators comprising two typical pedestal type units, carrying one and two jet pipe regulators respectively, a sectionalised model showing the method of operation of the jet pipe system, a standard butterfly valve, and lastly a combined regulator and instrument panel. The panel, which was to have been exhibited, is typical of this construction and actually constitutes a gas mixing station for a steelworks. The coke oven and blast furnace gas production of a modern steelworks is normally sufficient to meet most of the heat requirements of the plant, but to attain this end it is essential that the most efficient use be made of the gas available. Blast furnace gas does not, as a rule, provide a sufficiently high flame temperature for soaking pits and reheating furnaces, unless a certain amount of coke oven gas is added so that mixed gas is commonly furnished to such consumers. It is obviously necessary, however, that once decided on, the calorific value and therefore the mixture ratio should remain constant irrespective of variations in consumption and fluctuations in the supply pressures of the two gases. It is also desirable that the supply pressure of the mixed gas should be constant. At the same time provision must be made to enable the mixture ratio and supply pressure to be readjusted from time to time as operating conditions demand. Since the blast furnace gas usually constitutes the larger fraction of the mixture, it is usual to regard the blast furnace gas as the primary flow, and to control the coke oven gas as a secondary flow in constant ratio to the blast furnace gas.

The mixture regulator accordingly operates a butterfly valve in the coke oven gas main controlling the admission of coke oven gas into the blast furnace gas main. Unless the coke oven gas pressure is always appreciably above that of the blast furnace gas it is clear that reversal of flow may sometimes occur, *i.e.* blast furnace gas may flow up the coke oven gas main. To prevent this and at the same time to ensure a constant mixed gas pressure, a second regulator is usually installed, operating a butterfly valve in the blast furnace gas main, and maintaining constant pressure in the mixed gas main at a value below the minimum coke oven gas supply pressure. Both butterfly valves are, of course, upstream of the mixing point. The gas quantities are measured by orifice plates in the usual way. These orifices set up differential pressures which are proportional to the square of the gas flows, and which operate both regulators and gas meters.

The panel is of the two-bay arrangement, one bay accommodating the Kent blast furnace gas meter and the mixed gas pressure regulator, while the other carries the Kent coke oven gas meter and the mixture regulator. The Kent meters are flush mounted on the panel front, while the two Reavell-Askania regulators are carried on stools at the back of the panel. The adjustments for mixture ratio and gas pressure are operated from the panel front, a dial indicator being provided below the coke oven gas meter to show the position of the mixture ratio adjustment. In the case of the pressure regulator a Cambridge gas pressure indicator is substituted for the dial adjustment indicator. Both regulators are provided with hand control on the Lockheed system. This is a slight modification of the well-known Lockheed apparatus in so far as the Lockheed transmitter, which is a hand-driven two-cylinder pump, operates the Reavell-Askania control cylinders instead of the usual Lockheed slave cylinders. When hand control is required, the regulator is isolated by a "hand/automatic" changeover-valve operated from the panel front. A single transmitter is used and may be put into communication with either control cylinder by means of a two-way selector valve, also mounted on the front of the panel. The butterfly valves are operated simply by rotating the transmitter handwheel, the valve opening or closing according to the direction of rotation. Lockheed "hydrolock" valves are incorporated in the pipe system to isolate the Lockheed apparatus automatically from the control cylinder and regulator when the control is automatic. All interconnecting piping between the regulators and the Lockheed apparatus is fitted up on the panel, leaving only a pair of connections for each regulator between the panel and the control cylinder mounted on the butterfly valve and the oil delivery and drain connections between panel and pumping plant to be made at site. Similarly all impulse pipe branch connections to regulators and meters, equalising and isolating valves, etc., are made on the panel, so that the connections to be made at site comprise only a single pressure connection from the mixed gas main, and two pairs of differential pressure connections from the blast furnace and coke oven gas orifice plates to the panel. The work on site is thus reduced to a minimum.

The Reavell-Askania regulators are of normal construction, but it will be realised that the operating conditions call for apparatus of very high precision. The variations in gas volume may be very wide, particularly if the mixing station supplies a number of consumers. The permissible differential pressure for gas measurement does not usually exceed 2in. w.g. at maximum flow. If the load is reduced to say 20 per cent. the differential pressure falls to only 4 per cent. of the maximum value, *i.e.* to 0·08in., so that the mixture regulator has to maintain in constant ratio two such pressures of this order. If the error is not to exceed say 2 per cent. the regulator must respond to differential pressure variations of 0·001–0·002in. w.g. All details of such panels are standardised as far as possible, and they are built with six or more bays to cater for such cases as automatic boiler controls and temperature, combustion, furnace pressure, etc., controls for large reheating furnaces. The oil pumping plant, usually a motor-driven gear pump mounted on a large capacity oil tank, is in most cases separate from the panel.

(To be continued)

High-Speed Lightweight Trains *

By C. T. RIPLEY †

During the last twenty years the travel habits of the American people have expanded greatly. The development of the low-priced automobile, and the construction of hard-surfaced roads have been the major factors in this change. In the face of increased travel, railway passenger traffic steadily declined, until in 1933 it produced only about one-third the gross revenue which it did in 1920. The data in Table I show this decrease both in the number of passengers carried and in the rates and revenues.

The large decrease in railway passenger traffic was undoubtedly due to the inroads of bus travel, private-automobile travel, and to a lesser degree airplane travel. Prior to 1930, the railway managements, with properties still fairly prosperous because of good freight traffic, did little to remedy the situation except to reduce rates, as indicated in Table I. They also eliminated some nonpaying trains and in the case of branch-line operation, where they were usually forced by governing bodies to continue passenger service regardless of losses involved, they substituted gasoline-electric motor cars for steam trains. These cars were definitely successful in reducing operating costs to such an extent that their first cost was paid for in a few years, but there was nothing about their service to attract new passenger business or even to hold what was left. Their usage did influence later developments in that they brought to the attention of railway managements the possibilities of utilisation of the internal-combustion motor in railway service. Their success in mechanical performance led the manufacturers to develop the new type of lightweight two-stroke cycle Diesel motor, which is now playing such an important part in the operation of high-speed streamlined trains.

Table I.—*Passenger-traffic Statistics, Class* 1 *Railroads in United States*

Year.	Passenger revenue, dollars.	Revenue per passenger mile, cents.	Passengers carried.
1921	1,153,792,000	3·09	1,035,496,000
1925	1,057,704,231	2·94	888,267,000
1930	729,470,279	2·72	703,598,000
1933	329,342,000	2·01	432,980,000
1934	346,325,993	1·92	449,775,000
1936	412,379,000	1·84	490,091,000
1937	442,809,000	1·79	497,288,000
1938	405,476,000	1·87	452,808,000

About 1930 the railroads started air-conditioning passenger cars. This was an instant success with passengers and though the cost was high, about $8000 per car, it became necessary to air-condition practically all main-line cars, with the result that there are now about 11,000 such cars in operation. In some of these cars there were other improvements made for the comfort of the passengers such as more comfortable seats and better lighting. The success of this development, from a traffic viewpoint, convinced the passenger-traffic officers that it might be possible to recapture at least a part of the lost business.

In 1900 the 60ft. wooden passenger car, seating about 80 passengers, weighed about 40 tons or 1000 lb. per passenger. In the interests of safety, designs were changed first to include steel underframes, and in about 1910 to all-steel construction. Various parts were also increased in size and weight in order to secure greater strength and durability, until in the 1920's the 80ft. passenger car seating about 70 passengers weighed approximately 80 tons or 2300 lb. per passenger. About 1930 still further weight was added, due to the introduction of air-conditioning equipment, weighing about 5 tons. As a result of this continued increase in weight of passenger cars, as well as a gradual increase in the speed of operation, the size of steam motive-power units steadily increased. Track structures and bridges had to be made stronger to carry these heavier locomotives and cars, and thus there was, from all of these angles, an increase in the cost of operating passenger trains, while at the same time the total traffic was diminishing and there was a continual demand for lower rates to save the remaining traffic.

Development of Lightweight Cars

About this same time some new structural materials became available for use by the car builders, namely, aluminium alloys, stainless steel, and various so-called low-alloy high-tensile steels. Because of these developments the railway engineers and the car manufacturers started active work in the design and construction of new trains of a lighter type for main-line operation. The first of these were small trains consisting of three or four cars with 600 H.P. Diesel engines located in the head car. They were made as light as possible in order to hold down the power requirements and to enable them to compete with buses and private automobiles by giving cheap transportation. The cars were of non-standard height and some were narrower than the standard. They were streamlined to reduce power requirements and also to make an appeal to the public, already educated to such design by automobile developments. The reaction of the travelling public was so favourable that there was an immediate demand for more elaborate and larger trains for longer runs, with sleeping accommodations and other features for maximum comfort. Low first cost was soon lost sight of in this development. Interior decorators designed the most elaborate fittings and the trains were built with as many as 14 cars with power units totalling as much as 5400 H.P. and auxiliary power for the cars of 1200 H.P. A few of these trains were powered with streamlined steam locomotives but there was little change in the design of these locomotives from the old type except that higher driving wheels (84in.) were used together with higher steam pressures (300 lb. per square inch) and larger tenders to reduce delay in taking fuel and water. They also had roller bearings and some other refinements in design.

Most of the early trains had articulated cars because it was thought that this design reduced weight and gave better riding conditions. It developed however that neither of these factors proved to be important. There was a definite disadvantage in articulation particularly on long runs, in that standard cars could not be mixed with such cars. In case of difficulty, such as a bearing or wheel failure, a car failure might become a train failure. In the last few years practically all the lightweight cars have been built as individual units with standard floor and coupler heights and standard outside dimensions, so that they can be associated with any standard car. The weights of these cars were reduced about 40 per cent. from those of the conventional structural-steel cars and thus four-wheel trucks could be used.

Specification Requirements for Passenger Cars

The only standards for design strength available at the time most of these cars were built were the provisions of the United States Railway Post Office mail-car specifications. These specifications were first prepared in 1912 by a group of representatives of the Post Office Department, the Master Car Builders Association, and the car manufacturers. It was required that all postal cars meet these specifications. While other cars were not required to meet them, practically all passenger-train cars were designed at least to these requirements. In July, 1938, they were revised to clarify certain features. These new specifications were written so as to cover practically

* *The American Society of Mechanical Engineers*, Sept. 4–8, 1939.

† Chairman, A.S.M.E. Railroad Division.

all types of construction with all types of materials. The major provisions of both the 1912 and 1938 specifications were, first, a minimum strength of centre-sill construction based on 400,000 lb. buffing static load and a factor of safety of two, and second, a minimum strength of end construction to protect against telescoping action. This latter required minimum section moduli for vertical end members and minimum shear values for their top and bottom connections. There were also numerous other limitations of stress in frame members.

Cars built to meet these specifications have rendered excellent service with a remarkably good record in the protection of passengers under wreck conditions. As a consequence when lightweight construction was started in about 1931 these specifications were used as a minimum requirement, even though there were no rules of the American Railway Association or of the Government setting such limitation. However, a feeling developed that because of the operation of lightweight cars between heavy cars in trains, it was necessary for the Association of American Railroads to set up more detailed specifications to cover the construction of all passenger-train cars built in the future, giving particular attention to prevention of damage from telescoping. A committee of the Association of American Railroads has recently developed these new specifications and they will probably govern all new construction of passenger cars. While these new specifications are generally based on the Railway Post Office specifications, they include some major changes: They provide for a centre-sill strength such that an 800,000-lb. load applied on line of draft will not produce any permanent deformation. The Railway Post Office specifications contained only a stress limitation and permitted the load application to be divided between the coupler line and the buffer line. This change will probably result in the addition of more material than is now used in centre sills of lightweight cars designed with high centre sills and buffers, with little compensating benefit from added protection. The new specifications also include increased requirements for strength of couplers, carrier irons, and end construction, all of which mean some increase in weight, but which are apparently justified in view of the importance of maximum protection against telescoping of cars.

Generally speaking, the new lightweight cars are being designed and built just as strong and safe as the older heavy types. Better engineering, stronger materials, and improved methods of fabrication make this weight reduction possible. New welding technique largely eliminates the human element and when properly applied should be preferable to the old riveting practice.

Need for Light Weight

Light weight is almost a necessity for high-speed operation in order to hold down the size and cost of power units, as well as the cost of operation. This is particularly true with Diesel-electric locomotives with their high first cost. Experience indicates that 450 lb. per H.P. (including weight of locomotive) is a proper design ratio for high-speed operation. Some of the new trains have a power ratio as high as 550 lb. per H.P. but the maintenance costs appear to run higher on such trains. In order to secure satisfactory performance on high-speed schedules, it is necessary to have some reserve power in the locomotive because some delays are inevitable and extra power is needed to make up the lost time. While the schedules may indicate that maximum speeds of only about 90 m.p.h. are required, actual operation requires at times speeds of 100 m.p.h. or even higher. This fact must be taken into consideration when designing locomotives and trains for this type of service.

Car Construction Materials

Several of the early trains were built of aluminium alloys but in recent years the majority of them have been built of stainless steel or low-alloy high-tensile steel. The major claims for the stainless steel are lower weight due to higher physical properties, better welding by the automatic Shot-Weld process, and high resistance to corrosion. Stainless steel does not have to be given paint protection of any kind, which reduces both first cost and maintenance cost. Its polished surface gives an attractive modernistic appearance to the cars and is easily cleaned. In high-speed operation the sandblast effect of particles from the ballast or right of way damages paint finishes quite rapidly. The low-alloy high-tensile steel advocates claim that they secure equally low weights for lower costs. Tests indicate that these steels have from two to four times the corrosion resistance of ordinary carbon steel. They are made to various formulas and have different trade names. It is claimed that some of them have somewhat better welding qualities than others.

Inasmuch as no exactly similar cars have been built using the different types of steel or aluminium, it is not possible to make accurate weight comparisons. While it is true that the full use of the superior physical properties of stainless steel or the light weight of aluminium is limited to some degree by deflection requirements, it should be possible, by using these materials instead of low-alloy steel, to construct a lighter car of equal strength. A general comparison of the large number of cars of the various types which have been built indicates a weight advantage for stainless steel and aluminium of at least 5 per cent. It would be expected that the construction cost of cars built of these materials would be somewhat higher due to the high cost per pound of such materials, but competition between builders has resulted in about equal bid prices. In Table II are shown the properties of various lightweight materials.

Table II.—*Physical Properties and Composition of Materials used for Passenger-car Bodies*

	Structural steel for cars	Typical low-alloy high-tensile steel	Stainless steel Grade 1	Stainless steel Grade 2	Typical aluminium alloy 178T
Minimum yield point, 10^3 P.S.I.	*	50	110	120	32
Minimum tensile strength, 10^3 P.S.I.	†	70	140	150	50
Minimum elongation in 2 in., per cent.	25	22	18	18	8
					18
Modulus of elasticity, 10^6 P.S.I.	28	28	27	27	10·5
	30	30			
Carbon, per cent.	0·30	0·10	0·08	0·08	—
			0·20	0·20	
Manganese, per cent.	0·30	0·10	0·70	0·70	—
	0·60	0·50	max.	max.	
Copper, per cent.	0·20	0·30	0	0	4·0
Chromium, per cent.	0	0·50	18	18	—
		1·50			
Nickel, per cent.	0	0	8	8	—
Approximate cost, cents per lb.	2½	3½	35	35	35

* One half tensile strength. † 50,000 to 60,000 P.S.I.

It is too early to evaluate fully the different types of lightweight-car construction. Maintenance costs over a longer period and performance in accidents will ultimately provide the answer. It appears, however, that a weight of about 100,000 lb. for an 80ft. coach is entirely practicable with full safety to passengers. If too much space for extra luxuries is provided, part of the advantage of lightweight construction is lost, as the important factor is the weight per passenger carried. Table III shows the major parts of a typical lightweight car in which the weight saving has been made.

Table III.—*Comparative Weights of Conventional and Typical Lightweight Air-conditioned Passenger Coaches*

	All weights in pounds	
	Conventional steel coach.	Lightweight stainless-steel coach.
Length over end sill, ft.	70	79
Seating capacity	58	63
Weight of trucks	52,800	34,000
Weight of car-body structure	66,500	33,000
Weight of inside furnishings	7000	5000
Weight of equipment	45,400	25,000
Total weight	171,700	97,000
Weight per passenger	2962	1540

Riding Characteristics of Lightweight Cars

Due to higher operating speeds, the design of passenger-car trucks is a most important factor. The former six-wheel trucks were not entirely satisfactory at these increased speeds, and doubt existed in the minds of some engineers as to the possibility of securing good riding qualities with four-wheel trucks. The weights of the new car bodies were so low that only four axles were necessary to carry the load, affording further opportunity for weight reduction by the use of four-wheel trucks. Extensive experiments were made by various railroads and manufacturers, which resulted in the development of many new features of truck design with a decided improvement in riding characteristics.

Among these new features were the use of softer springs with greater deflections, hydraulic shock absorbers to control both lateral motion and vertical spring reactions, multiple-spring systems in triple-bolster trucks, and roll stabilizers. The use of cylindrical tread contours on wheels to reduce the nosing of trucks, and the grinding of treads to secure true rotundity and concentricity, were both helpful in softening the ride. Balancing of the wheels was also practiced to some extent, although a complete check of this feature has not been made due to lack of balancing machines in this country. It is now being given careful check on one railroad, which has installed the necessary machine. In an effort to reduce noise in the cars, rubber or other semi-resilient materials have been introduced in various parts of the trucks, such as pedestals, spring seats, and centre plates. The mounting of the brake cylinders on the trucks instead of the body has also reduced the noise produced by the brakes. Improved insulation of car floors, as well as the sealing of windows, has also made a marked improvement, but there is still need for further noise elimination. The passengers can still hear the click of the wheels on the rail, the grinding of brake shoes on the wheels, and in some cases generator noise. Longer rails and better track maintenance would help to reduce rail and wheel noise and the use of disk-type brakes would reduce brake noise.

In some of the lightweight cars a certain amount of vertical body vibration was noticeable to passengers. This has been reduced by stiffening the car-body structure. The fore-and-aft vibration of cars which is so noticeable in many of the standard cars, particularly in operation with reciprocating steam locomotives, has been largely eliminated through the use of tight-lock couplers, which have little or no free slack and by softer acting draft gears.

The most unpleasant shocks in these cars are those of lateral acceleration, resulting either from nosing of trucks on tangent track, or the entering or leaving of curves. A novel attack on this problem is being made by one manufacturer, who has developed a pendulum type of car. This method of mounting the car on the truck differs completely from standard practice, in that the car body is virtually suspended from the truck, floating on soft vertical helical springs located well above the centre of gravity of the car body. These springs permit through horizontal deflection the necessary truck motion relative to the body, and this motion is positioned and controlled by a pair of horizontal links, which are restrained by rubber disks and shock absorbers acting between the car body and vertical extension of the truck frame at a point above the centre of gravity of the body. In going around curves this type of car tends to bank and thus avoids the unpleasant sensation resulting from car-body roll. Preliminary tests of this type of car indicate an improvement in riding characteristics, particularly on curves.

In general it appears that there is still need for research in truck design, in order to secure even greater comfort for passengers and to make possible higher operating speeds on sharp curves which, particularly on western roads with much track curvature, are a definitely limiting factor to fast over-all operating schedules.

Improvements in track structure and maintenance are also necessary if still higher speeds are to be attained. Whatever design of truck is used, satisfactory riding characteristics cannot be secured in high-speed operation over bad track.

Braking

The introduction of high-speed lightweight trains brought many new problems in braking. The stopping of these trains within reasonable distance is a difficult problem. While the car weights are less, individual wheel loads are as high and in some cases (particularly with the articulated type) higher than with the old heavy cars. In order to reduce the stopping distance, there have been a number of changes from former practice, such as truck mounting of brake cylinders which increases rigging efficiency, much higher braking ratios (some as high as 250 per cent.), decelakrons to reduce pressures as the train slows down and thus prevent sliding of wheels, automatic car sanders acting only in emergency application, and electro-pneumatic control. In some cases the very high brake ratios resulted in considerable wheel and brake-shoe trouble. With all of these improvements there is still a question whether emergency stopping distances are as short as they should be. To effect shorter stops without undue punishment to wheels and shoes, new types of disk brakes are being tested. One train so equipped is now in operation. This type of brake has the advantage of a more uniform coefficient of friction throughout the speed range, thus permitting brake pressures which more closely approach the coefficient of adhesion between the rail and the wheel. Unfortunately, this coefficient of adhesion varies widely under different rail conditions. Thus if higher braking pressures are used, there is danger of sliding under unfavourable conditions. To meet this problem, either car sanding equipment or governors to reduce pressures automatically, when sliding begins, may prove to be a necessary complication.

In both steam- and Diesel-powered lightweight trains, the locomotive weight is a large percentage of the train weight, but in most cases locomotives do not do their full share of the braking. The steam locomotive is particularly lacking for three reasons: First, there are often some unbraked wheels on engine trucks for operating safety; second, the large spread between light and loaded weight of tenders makes it necessary to design braking power on the basis of light weight; and third, enginemen have to relieve engine brake pressure frequently to guard against the loosening of driving tyres due to heating. The Diesel is better in that all wheels are braked and the spread between light and loaded weight is relatively small, but the small-diameter wheels are so highly loaded that the braking ratio must be limited in order to protect the wheels from damage. It would be advantageous if Diesel-electric locomotives had a supplementary dynamic electric brake such as is used in some electric locomotives as well as in the new experimental turbo-electric design.

Comparison of Diesel-Electric and Steam Locomotives

The Diesel-electric locomotive is more commonly used in these new high-speed streamlined trains than

is the steam locomotive. It is claimed by some that this is chiefly due to the interest of the public in a new type of power, but the users apparently have good engineering arguments to support their choice. The advantages claimed for the Diesel are: First, high availability; second, rapid acceleration because of high tractive power at lower speeds; third, low maintenance costs; fourth, low fuel cost (usually less than half that of steam); fifth, lower rail stresses. The steam locomotive is less expensive, costing about $37 per H.P. However, it is harder on track at high speeds due to the dynamic augment produced by overbalance in the driving wheels. It appears that a radical change in the design of the steam locomotive is necessary to make it capable of fully competing with the Diesel in this service. The important objects of such redesign should be the securing of a more constant torque and the reduction of track punishment. Thee outstanding locomotives of new design are under construction or in service, namely, the 5000-H.P. turbo-electric being manufactured by the General Electric Company for the Union Pacific Railroad, the Baltimore and Ohio Railroad's four-cylinder engine, and the Pennsylvania Lines' four-cylinder high-speed engine. All of these new types are experimental, but they indicate a trend towards a type of steam locomotive having more constant torque. A step still further in this direction is involved in a new Baltimore and Ohio design, which includes individual axle drive.

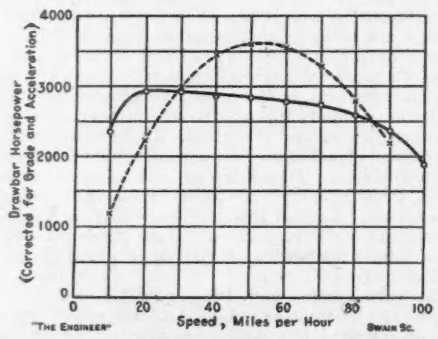
The comparison of typical modern high-speed steam locomotives and Diesel-electric locomotives on a horsepower basis, is as shown in Table IV, open to

TABLE IV.—*Comparison of Typical Modern High-speed Steam and Diesel-electric Locomotives*

	Diesel-electric.	Steam 4–6–4	Steam 4–8–4
Nominal H.P. of Diesel motors	4000	—	—
Maximum indicated H.P.	—	4300	5750
Weight with fully loaded tender, lb.	608,000	809,000	896,000
Weight, lb. per H.P.	152	188	156
Approximate cost per H.P.	$87.50	$35.00	$34.00

criticism because of the basic difference in the horsepower curves of the two types and also the difference in method of power transmission. The nominal horsepower of the Diesel-electric locomotive is available over practically the entire speed range, whereas the maximum indicated horsepower of the steam locomotive is available only during a limited speed range. With locomotives of equal horsepower, the Diesel has the advantage of greater power for accelerating at low speeds and greater sustained horsepower at very high speeds. Some difficulties with pistons, heads, and liners have been experienced in services where Diesel-electric locomotives were operated with such loads and schedules as to require almost continuous maximum output of power. Recent improvements in materials and designs of these parts have largely overcome this trouble. Nevertheless, the maintenance cost of any type of locomotive increases as the working-load factor increases. Proper design of a motive-power unit should provide some reserve power for emergency use, but not such an excess as to result in uneconomically high cost of construction.

Fig. 1 shows the relative drawbar horsepower of a 4000 H.P. Diesel-electric locomotive and a modern



(Solid curve. Diesel-electric locomotive, 4000 nominal H.P. Dotted curve, 4–6–4 steam locomotive, 4300 maximum I.H.P.)

Fig. 1.—*Comparative Drawbar-horsepower Curves for Steam and Diesel-electric Locomotives*

(1938) high-speed steam locomotive of the 4–6–4 type with 4300 maximum I.H.P. These curves are plotted from actual dynamometer-car readings with necessary corrections for grade and acceleration. They show the advantage of the Diesel-electric locomotive at low speed and very high speed and also the advantage of the steam locomotive at intermediate speeds, such as would exist in ordinary grade working. This advantage in grade climbing is offset to a considerable extent by the 33 per cent. greater weight of the steam locomotive.

The sharp dropping off of the horsepower curve for steam locomotives at high speed is due largely to low mean effective pressure in cylinders. To improve this condition, radical changes both in the design of valve and of valve gears appear to be necessary.

In the case of Diesel-electric locomotives, the curve does not drop off as sharply as does that for steam locomotives and further improvement has already been secured in the latest designs by changes in the generator voltage control. This change has also increased the power output at low speeds.

In regular operation of the two types the performance of the Diesel-electric locomotive is usually that which is indicated by the drawbar-horsepower curve, but in the case of the steam locomotive there are a number of variables which may result in average performance somewhat below what is indicated by the horsepower curve derived from tests. The skill of the engineer varies and the condition of the locomotive is not always as nearly perfect as it is in the test.

Manufacturers of Diesel-electric locomotives have an advantage in that they produce a practically standardised product and thus can reduce cost through line production. On the other hand almost no two lots of steam locomotives are the same. Each order means a new design with resulting high costs for engineering and production. This also means higher cost for and larger stocks of repair parts. American railroads have made a marked advance in the standarisation of freight cars but there has always been strong opposition to any plan for standardisation of steam locomotives or passenger cars, due mainly to differences of opinion among different managements. The usual explanation is that operating conditions vary but this is hardly a valid excuse at least when certain railroads are compared.

The use of Diesel-electric locomotives is more extensive on western roads than on those in the east. This is probably due to the following factors: Most of the oil production is in this territory, which results in lower prices, and the traffic in oil and its by-products is a more important source of revenue than that from coal, whereas the reverse is true in the eastern territory. In the south-west most of the steam locomotives use oil as fuel because of its lower first cost. The usual Diesel-locomotive fuel is about 28-gravity furnace oil costing about four cents per gallon at the refinery. Steam-locomotive fuel oil is a low-grade residuum costing about two cents per gallon at the refinery. The boiler-feedwater supply and treatment is also much more of an expense and problem in at least a large part of the west than it is in the east.

Diesel-electric locomotives provide better vision for the engineer because the cabs are located at the head end. The riding quality of Diesels is better than that of steam locomotives. They also provide smoother-riding trains as their high tractive effort at low speeds enables them to start and accelerate trains more quickly and smoothly.

Steam locomotives have an advantage in that more horsepower can be put in one unit. It may be noted in Table IV that the increase in horsepower is secured with a lower percentage of increase in first cost and weight, that is, both the cost and weight per horsepower are lower for the 4–8–4 locomotives than for the 4–6–4 type. The maintenance cost per horsepower should also be somewhat lower for the 4–8–4 locomotives. It is true that any number of Diesel units can be coupled and controlled from one cab, but this increase in number of units means increased first cost and increased weight. A 2500-H.P. Diesel unit would appear to be a desirable size for heavy service, particularly in mountainous territory, but this does not appear practicable at present.

The performance records of Diesels show fewer failures than similar records for steam locomotives, even when the latter are operated in slower-speed service. The multiunit power plant is a helpful feature in the prevention of failures. If something goes wrong in one power plant the locomotive can still go on to its terminal and in many cases the defect can be repaired en route with little or no delay. A major breakage or defect on a steam locomotive means a failure.

If an entire territory were completely Dieselised, major savings could be secured in elimination of water and fuel facilities and also intermediate terminals. With partial Dieselisation, it is necessary to provide certain special facilities for water and fuel, but these are not expensive. Diesel-electric locomotives are designed to operate about 700 miles without refuelling or watering, whereas steam locomotives with large tenders operate only about one-half of this distance for fuel and one-third the distance for water. Fewer and shorter stops for fuel and water are essential in making high-speed schedules.

Diesel-electric locomotives have a higher availability than steam locomotives because they need less servicing. Furthermore, individual major parts can be changed in a short time, thus avoiding delay of the unit for repairs. In service they are regularly making 1½ to 2 times as much mileage as steam locomotives, though it is only fair to say that part of this may be due to their use on preferred runs. Diesel-electric locomotives are cleaner in their operation, due to lack of smoke. This is particularly advantageous in cities and towns. It also adds to passenger comfort in that the view from the car windows is not obstructed by smoke.

Table V gives a breakdown of the weight of a typical 2000-H.P. Diesel-electric locomotive. The large percentage of the weight involved in the trucks may be noted. This is due to the heavy construction needed to support the traction motors and withstand the shocks of high-speed operation. The trucks are constructed of alloy steel and there appears to be little opportunity of making them lighter. The Diesel motors are almost as light as they can be made to withstand the service, but it may be possible in future development to take more power out of each cylinder, which would result in a reduction of weight per horsepower. The transmission accounts for a considerable percentage of the total weight. There is some possibility of reducing both the cost and weight of this part through the development of suitable hydraulic transmissions, but no large locomotives of this type have as yet been built in this country. The weight of the body structure cannot be reduced to any great extent as alloy steel and welded construction are already used throughout.

TABLE V.—*Weight of Standard 2000-H.P. Diesel-electric Locomotive*

	Per cent.
Two 1000-H.P. Diesel motors and auxiliary equipment	23
Two electric transmissions with auxiliary equipment	21
One steam boiler with auxiliary equipment	2
Two trucks (less traction motors)	28
One car body	26
Total	100

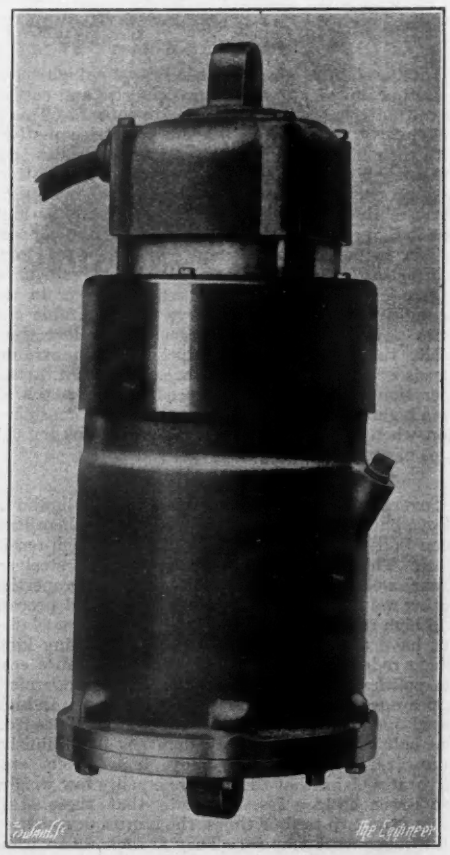
Total light weight	277,000 lb.
Weight of oil (1420 gallons)	11,000 lb.
Weight of water (1300 gallons)	10,800 lb.
Weight of sand (16 cu. ft.)	1600 lb.
Total	300,400 lb.

The centre of gravity of the Diesel-electric locomotive is considerably lower than that of steam locomotives and this fact, together with the shorter rigid wheel base makes it possible to operate the Diesel-electric locomotive at about 15 per cent. higher speeds on sharp curves. This is an important factor in making high-speed schedules, particularly on runs where there is a great deal of curved track.

(To be continued)

Thrustor For Small Power Applications

A SMALL size of electro hydraulic thrustor, introduced by The British Thomson-Houston Company, Ltd., has been specially designed for loads requiring a relatively small thrust of not more than 40 lb. through a 2in. stroke. The device is to be used for applications where the previous smallest size of thrustor (rated



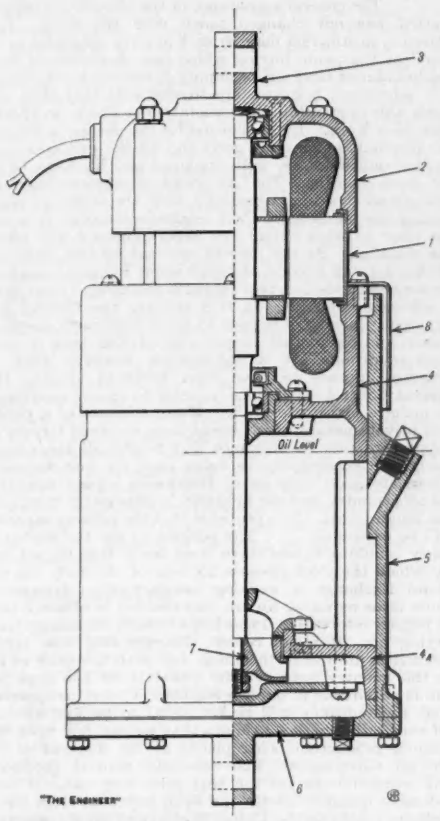
THRUSTOR FOR 40-LB. LOADS

75 lb. through a 2in. stroke) is unsuitable because of its physical size. The small output required from the new thrustor has permitted the adoption of a completely new and simplified design which has reduced manufacturing costs. This design, which is the subject of a patent application, is shown herewith. The number of parts involved has been reduced to a minimum by dispensing with the usual push-rods and crossbar, and building the motor end-shield in one casting with the piston, the pressure from the piston being transferred to the top clevis through

the motor casing. The unit has a rated output of 40-lb. pressure through a 2in. stroke, and for 3-phase systems is known as the Type TK.402.

The motor stator (1) carries the top end-shield (2), and the top connecting lug (3) is cast solid with this. The lower end of the stator shell is fixed in the end-shield (4) and the piston (4-a) is cast in one piece with this end-shield. The piston slides in the tank (5) and the bottom of the tank (6) carries the lower mounting clevis.

The impeller (7), mounted at the lower end of the motor shaft, generates a pressure below the piston when the motor is running, so that the piston and the



SECTIONAL ARRANGEMENT OF THRUSTOR

complete motor are forced in an upward direction, the impeller pumping the oil from the top to the bottom of the piston until the upper limit of travel is reached. If the motor is still energised, the impeller will maintain a pressure below the piston so that the latter is maintained in the top position. The cover (8) prevents dirt from falling into the tank and at the same time allows free movement of air inside the tank as the piston rises or falls.

From the illustration of the complete thrustor it will be seen that it is of particularly compact and robust construction.

A Mobile Oil Engine Alternator Set

THE mobile generating set shown in the accompanying illustration has been put on the market by Blackstone and Company, Ltd., and is being used by Government departments and local authorities as a ready means of providing electric current in case of emergency.

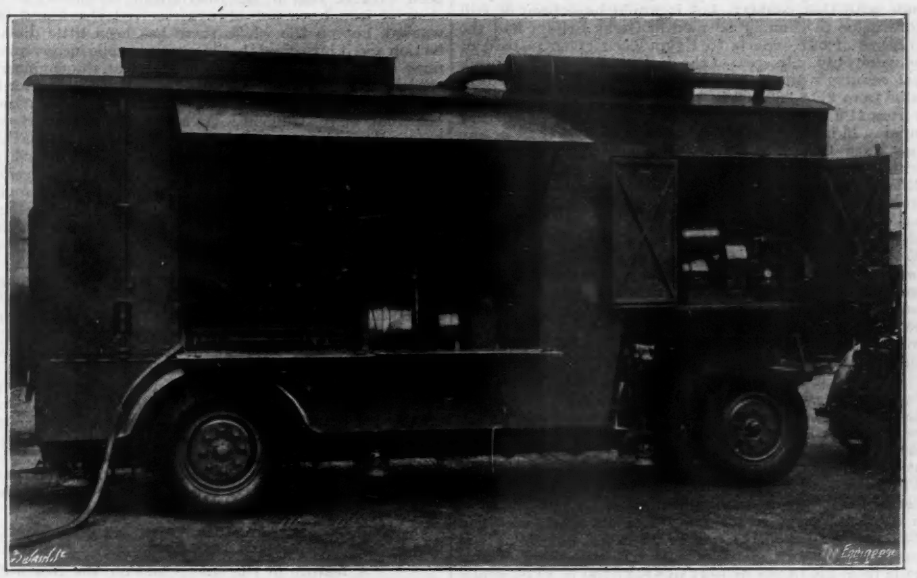
The set consists of a 120 B.H.P. Blackstone engine and a 75 kVA alternator on a trailer. When generating, the trailer is free from vibration. The smooth running of the engine, together with the efficient silencing of both the air intake and the exhaust outlet, reduce noise to a minimum. For transport purposes, the trailer can be coupled to any suitable tractor and hauled at a maximum speed of 20 m.p.h.

The chassis, manufactured by R. A. Lister and Company, Ltd., is made of rolled steel channel with welded cross members and has high pressure pneumatic tyres. The steering assembly carries the front axle, whilst the rear axles, each carrying twin wheels, are attached to laminated springs with trunnion ends. Internal brake shoes are fitted to each rear wheel. They are cable-operated at the drawbar end of the trailer when travelling, but for parking they can be applied by a handwheel at the rear end.

The trailer is totally enclosed and has ventilators with louvres in the roof and front panel. Double doors give access on the near side to the spare wheel and on the offside to the compressor set. The top two-thirds of the sides hinge to form a roof, whilst the lower one-third, constructed from chequer plating, hinges down as a platform. A large double door at the back gives access to the control end of the engine.

A fabricated steel baseplate, bolted to the chassis, carries the engine and alternator, which has a belt-driven exciter. The engine is a vertical Blackstone three-cylinder unit developing 120 B.H.P. at 600 r.p.m., direct coupled to a 75 kVA alternator generating at 230/400 volts, three phase, 50 cycles, 0·8 power factor. Six self-sustaining screw jacks, three on each side, take the weight off the springs and wheels when the plant is generating. The gross weight of the unit is approximately 15 tons.

The cables from the alternator terminal box are



MOBILE 75-kVA GENERATING SET

carried in a solid drawn conduit to the switchboard. Power to the external load is taken by a trailing cable permanently connected to the load side of the oil circuit breaker on the switchboard.

The compressor set comprises a 3 B.H.P. Lister air-cooled petrol engine coupled through reduction gear to a two-stage compressor. The unit is mounted on a raised platform at the front end of the trailer.

Six bulkhead fittings are provided for lighting, the interior lighting system consisting of two circuits —one at 230 volts when the plant is generating, the other from one of two 12-volt batteries, which are kept fully charged by a trickle charger.

The radiator is mounted on the front platform, the fan being driven from an extension of the alternator shaft. It cools both the circulating water and lubricating oil for the engine. The fuel storage tank is carried in the chassis under the engine bedplate, the fuel being transferred as required to the service tank, which has a gravity feed to the fuel transfer pump on the control end of the engine.

Sixty Years Ago

CLERK MAXWELL

Two days after its occurrence, we recorded in our issue of November 7th, 1879, the death at his home in Scroope Terrace, Cambridge, of Professor James Clerk Maxwell. We clearly recognised the greatness of the man. His death, following so closely that of Clifford, had, we said, considerably weakened the ranks of British science. Nevertheless we devoted not much more than a third of a column to his obituary notice. There are men who impress their greatness on their contemporaries without those contemporaries being fully certain of the nature of their greatness. Such a one, we may suppose, was Clerk Maxwell. It is certain that the importance and value of his work were not fully appreciated until, years after his death, developments of physical science made it apparent. We recorded that Maxwell graduated as second wrangler in 1854 and that he was bracketted equal with Routh—the senior wrangler of his year—for Smith's prize. His college —Trinity—elected him to a fellowship. Thereafter he was appointed Professor of Natural Philosophy at Mareschal College, Aberdeen. In 1871 he was elected the first occupant of the Chair of Experimental Physics at Cambridge and was placed in charge of the newly finished Cavendish Laboratory. That was all we said about his professional posts and it is about all there was to say. Of his attainments we spoke of his ability as a mathematician and of his great powers as an experimentalist. We spoke of the poetry which he wrote in his leisure hours, delicate airy verses treating grave scientific questions with inimitable originality, and of his small estate in Scotland to which he loved to retire when his work at the University permitted him to take a holiday. We spoke of his writings, his learned *Electricity and Magnetism*, a work which only the best mathematicians could follow, and his elementary treatise on heat, a book which all could read. Touching his scientific work, we mentioned his studies, in conjunction with Helmholtz, Thomson, and others, of molecular phenomena. In but one sentence—and that a badly constructed one—did we anticipate in any way the greatness which succeeding generations have found in Maxwell's work. His clear-sighted reasoning, we said, had pointed out innumerable fields of discovery; Gordon, Ayrton, Perry, and some others had done a little in following up the indications he had given but the amount which remained to be done was enormous. . . . Perhaps, after all, these closing prophetic words may be held fully to compensate for the brevity of our notice.

Schedule of Reserved Occupations

THE Ministry of Labour and National Service announces that the age of reservation under the Schedule of Reserved Occupations has been altered to eighteen years in respect of the following occupations:—Constructional fitter and erector (general hand); ship's plater (general hand); riveter (hand), ship; riveter (machine), ship; rigger (shipyard); seaplane float builder; boiler fitter or mounter; boiler pipe or tube fitter or expander; moulder, aluminium (general hand); moulder, non-ferrous metals other than brass and aluminium (general hand); sheet metal worker (vehicle and aircraft); machine tool fitter, erector; tool maker (not press tool), jig and gauge maker; turbine blader; tool-room turner; tool and gauge turner; machine tool turner; assembler, aircraft (wood); woodwork erector (aircraft); inspector, tester (aircraft body work).

The effect of these decisions is that no man from the occupations mentioned will be called up for service with the Forces. Any person desiring information as to his position under the Schedule should apply to any local office of the Ministry of Labour and National Service.

EXPRESSING SYMPATHY WITH THE ALLIED CAUSE.—We are informed by David Moseley and Sons, Ltd., that their Buenos Aires agent, when recently sending over very substantial orders, requested that 10 per cent. of his commission on the business and on any future orders be given to the Manchester Infirmary or the British Red Cross "as a modest contribution to help those suffering from defending freedom against brutality."

CHEMICAL RESEARCH.—The Council of the Chemical Society has formed an Advisory Research Council, the main function of which will be, when approached, to bring to the notice of Fellows and others engaged in chemical research subjects for investigation that are likely to be of potential value to the nation at the present time. It is hoped to effect liaison with Government Departments and industrial organisations so that the Advisory Research Council may be cognisant of pressing problems needing investigation, and thus be able to suggest lines of research of National value.

THE INSTITUTION OF CIVIL ENGINEERS.—In consequence of the outbreak of war, it has been decided by the Council of the Institution that the publication of "Engineering Abstracts" in sectional form must be suspended. Accordingly, Volume 2 of Section 1 (Engineering Construction), Section 2 (Mechanical Engineering), and Section 4 (Mining Engineering), has been terminated with the September issues, which have been dispatched to subscribers, complete with Author and Subject Indexes for the period January–September, 1939. The issue of Section 3 (Shipbuilding and Marine Engineering), which is compiled by the Institute of Marine Engineers in co-operation with the Institution of Civil Engineers and the Institution of Naval Architects, will be continued in its present form until further notice. The publication of the *Journal* of the Institution of Civil Engineers is to be continued, and it is intended to include in each issue a selection of brief abstracts of important Papers and articles appearing in the home and foreign technical literature dealing with the branches of Engineering covered by Sections 1, 2, and 4 of "Engineering Abstracts."

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

British Trade with Egypt

The Report on Economic and Commercial Conditions in Egypt published by H.M. Stationery Office, price 2s. net, gives an interesting review of our export trade with that country, but it would have been of still more value to commercial men in Great Britain had the tonnages of our exports to Egypt been given instead of the value only. In spite of the decline in the total imports that country's purchases of British goods rose slightly in value from £E.8,280,000 in 1937, to £E.8,422,000 in 1938, or from 21·8 per cent. to 22·9 per cent. of the total. British imports, in fact, were greater in value in 1938 than in any year since 1930. In the case of agricultural machinery British exports declined and for 1937 were valued at £E.41,946 against £E.37,195 in 1938. The Report points out that this decline occurred in agricultural machinery and tractors since the value of pump imports, which are largely used in Egypt for irrigation purposes, rose from £E.19,689 in 1937 to £E.23,846 in the following year. Nevertheless, the British percentage share of the pump trade fell from 35 per cent. in 1937 to 27 per cent. last year. Germany's trade in agricultural machinery increased to nearly £E.10,000 in 1938, but fell in tractors from £E.43,898 in 1937 to £E.25,784 in 1938; whilst her trade in pumps averaged about £E.5,000 in each year. Switzerland more than doubled her trade in pumps and the imports from the United States also rose. The Report points out that the Government and the public are beginning to appreciate the virtues of air conditioning, but the demand remains small because the cost of installation and upkeep militates against its more general use. It is probable that eventually Egypt will become a valuable market for the air-conditioning industry. There was a rise in the total value of machine tools imported, which in 1937 reached £E.35,151 and in 1938, £E.46,083. There was a satisfactory increase in the British share of this trade from £E.13,268 in 1937 to £E.27,790 in 1938, whilst Germany's trade remained fairly constant at £E.9000. There was a sharp rise in the total value of the imports of cast iron and steel pipes from £E.227,000 in 1937 to £E.409,000 in 1938. The rural waterworks' programme and the Government were no doubt responsible for this expansion. Pipes to the value of £E.400,000 were ordered in 1938 for the contracts in this programme. The British share fell from 30 per cent. to 22 per cent. whilst Germany, who was second in 1937, became the largest supplier in 1938.

Our Imports and Exports

The Board of Trade Returns for September have made their appearance in an almost unrecognisable form. They consist of eight pages, compared with the 308 pages normally published. No particulars of exports are given, nor do the Returns contain the tonnage figures for the various items included. The value, and the relative increases or decreases compared with September, 1938, and 1937, are given; but only for the totals of the articles concerned. As regards imports, the quantities of iron ore and scrap sent into the country in September amounted in value to £648,348, which was an increase of £185,361 compared with September last year and a decline of £769,199 compared with the value in September, 1937. Non-ferrous metaliferous ores and scrap were imported in September to the value of £1,206,428. This was an increase on the corresponding figure for 1938 of £197,174, but a decrease when compared with September, 1937, of £367,117. The value of iron and steel and manufactures thereof imported in September was £1,163,969, which again showed an increase of £383,287 when compared with 1938, and a decrease of £1,064,419 from the figure for September, 1937. Non-ferrous metals and manufactures thereof were imported to the extent of £2,535,610 which was lower by £832,622 than in the same month of last year, but showed a decrease when compared with September, 1937, of £2,792,175. Machinery imports reached £1,418,660, which was £216,296 less than in 1938 and £584,855 less than in 1937. . . . It is not altogether surprising that as the war started on September 3rd, exports should show a general decline. The exports of coal reached in value £2,280,266, a decrease of £846,623 from September, 1938, and £1,264,418 in September, 1937. The value of exports of iron and steel and manufactures thereof totalled £1,634,234 in September, which is £1,361,388 less than in that month last year, and £2,321,499 below the figure for September, 1937. The exports of non-ferrous metals and manufactures thereof were valued at £558,493, a decline compared with September, 1938, of £346,068 and of £721,088 from September, 1937. Machinery was exported in September to the value of £2,259,796, but this figure is lower than the exports in September, 1938, by £2,212,050 and less by £1,993,368 than in 1937. Vehicles, including locomotives, ships, and aircraft, were exported to the value of £1,630,387, a heavy decline when compared with the figure of £3,945,452 in September last year, whilst they were £1,525,751 less than the value of the exports in September, 1937.

The Pig Iron Market

Business in pig iron in all districts has become active and the amount of new orders which are reaching the producers has occasioned some embarrassment in certain departments. Practically the whole production is required by firms engaged directly or indirectly upon war work and so far as can be seen the needs of consumers will broaden rather than decrease during the coming months. The position, however, is fairly satisfactory as the supplies are being distributed with regularity and users are obtaining the quantities they require. The light castings industry is using more foundry iron than for a long time as the foundries are becoming more and more involved in wartime production. There has been a decline in the demand for materials used in the building trade and normally supplied by the light castings makers, but the loss in this direction has been more than made up by the increased requirements for national purposes. There has been a fairly strong request for high phosphoric foundry iron in marked contrast to the conditions which ruled previous to the outbreak of war. Some complaint has been received that in the distribution consumers of this class of iron have not always received the brand they wanted, but on the whole there has been little dissatisfaction and it is realised that in wartime some inconvenience must be expected. The great activity at the engineering works has resulted in an expansion in the demand for low phosphoric qualities and the position in this market is becoming more stringent. As a result a number of users have taken to using hematite. It is thought that any tightness in the market for low phosphoric iron will not be of long duration and that by the middle of November there should be a distinct improvement in supplies. It is interesting to note that although the duty upon foreign pig iron has been removed there has been little inquiry for imported material from abroad. The price of Belgian iron, for instance, has increased to about £5 per ton f.o.b. and at this figure there is a substantial margin in favour of British iron. On the North East Coast there has been no expansion in the production of Cleveland No. 3 and most of the pig iron producers are concentrating upon the production of steelmaking iron. Consumers, however, appear to be able to obtain their requirements, which are also met by supplies of Midland irons. The situation in the Midlands is unchanged and the demand is still chiefly for low phosphoric qualities of foundry iron for the engineering trades. In Scotland the pressure for supplies of foundry iron appears to have increased and lately there has been some delay in deliveries. Business in hematite iron has been on a good scale but supplies have been ample for users' requirements.

The North East Coast and Yorkshire

A feature of the steel trade on the North-East Coast is the incessant pressure which is exercised by consumers anxious to obtain delivery. This affords some indication of the huge demand since notwithstanding the fact that production in all departments of the steel industry is being strained to the limit it is almost impossible to keep abreast of users' requirements. The manufacturers are doing their utmost to maintain regular deliveries and in this they are assisted by the Control, but it is inevitable that under existing conditions there should be some delay in deliveries, and that these are not worse than they are is to the credit of the industry. In the last half of October there was some decline in new business as consumers were awaiting the publication of the new prices; but the expectation of a readjustment of values, which usually disturbs the trade for some weeks, has had comparatively little effect, as the bulk of the steel now being bought is required for national purposes. The demand for billets and sheet bars is on a huge scale and although the producing departments are working at capacity they cannot keep pace with the requirements of the re-rolling trade. Considerable quantities of foreign billets, however, are available and although the re-rollers may experience difficulty in maintaining their works in full swing it is likely that this situation will improve in the near future. The sheetmakers are still busy upon sheets for A.R.P. but to a lesser degree than some weeks ago, and lately there has seemed more material available for other purposes. There has been no diminution in the demand for bars, angles, joists, and sections and important tonnages are passing to the constructional engineering firms, all of whom are busily employed chiefly upon Government contracts. There is not likely to be any decrease in the requirements of this industry but firms are not finding it easy to place orders for near delivery as most of the steelworks are booked up for some time to come. Conditions in the Yorkshire steel market are similar to those ruling in other parts of the country. The higher quality steels produced in Sheffield are in particularly strong demand and most of the production is going into use for war purposes. Lately, however, some observers have professed to see an improvement in the position as regards supplies for ordinary commercial work and for export.

Current Business

The Manchester Branch of the Electrical Contractors Association has circularised its members asking for a list of surplus electrical goods on hand for which a market is required. The intention is to compile a register to facilitate the distribution of such goods amongst contractors and retailers in need of them. Plans have been approved by the Ayr Dean of Guild Court for the erection of new workshops and offices in West Sanquhar Road for the Scottish Stamping and Engineering Company, Ltd. It is estimated that the cost will be £5700. It has been decided by the Tyne Improvement Commission not to proceed with the construction of a deep water quay at Tyne Dock. Work will proceed on the new 800ft. quay at the north-west corner of the Dock, which will cost £250,000. The Department of Overseas Trade announces that the following contracts are open for tender (in each case local representation is essential and all telephonic communications should be made to Extension 253):—South African Railways and Harbours Administration: supply and delivery of quantities of hexagon tapped steel buffer nuts (Johannesburg, November 30th); supply and delivery of quantities of bar steel (Johannesburg, January 4th, 1940). Egyptian Ministry of Public Works, Mechanical and Electrical Dept.: supply, delivery, and erection of a complete filter plant comprising two raw water centrifugal pumps, one coagulating apparatus, two gravity filters, one sterilising apparatus, and one filtered water pump (Cairo, November 15th). Australia, Brisbane, City Electric Light Company, Ltd.: supply and delivery of one electrically driven laboratory coal crusher or crusher sampler having a capacity of 5 cwts. per hour; one electrically driven sample grinder; one sample splitter (Boundary Street, Brisbane, November 28th). Egypt, Prisons Administration of the Ministry of Social Affairs: supply and delivery of 8 ventilators with totally enclosed motors; 5 complete humidifiers; loom for weaving Turkish towels; winding machines; 2 dobbies each with 20 shafts for handloom (Cairo, December 5th).

Copper and Tin

The general appearance of the electrolytic copper market has not changed much over the week. The situation in America may be said to have improved in as much as the panic buying which has characterised that market almost since the beginning of the war has declined. The producers, however, are so well sold that they are easily able to maintain their quotation at 12.50c. to 12.90c. f.a.s. New York. Even allowing for the decline in buying the demand is still quite good and all the principal consuming industries are well employed and likely to be so for some months. The American consumers have to look ahead now and apparently they are averse to postponing the purchase of their requirements since it is not yet clear to what extent the export demand will affect the situation. At the present moment neutral countries are buying with freedom although where European markets are concerned the fact that copper is contraband must have a sobering influence. In this country the Control has apparently plenty of copper to meet consumers' requirements, and the market seems to be settling down to wartime conditions. It is unfortunate, however, that no progress appears to have been made in altering the present Control restrictions in order to enable merchants to make a legitimate profit. Many schemes of a public and private nature which would have involved the use of copper are now in abeyance and nearly all the copper going into consumption is being used for war purposes. There are good supplies of Rhodesian copper available for this country, but the difficulty is principally in refining the rough metal. It is probable that the refinery capacity will be expanded. . . . The position of the tin market is fairly comfortable and there is no doubt that the scheme by which the Pool releases 25 tons of tin daily for the Metal Exchange is working satisfactorily. Apparently those firms requiring tin are thus enabled to obtain 5 tons at regular intervals and this helps to keep the market from drying up. It is, of course, disappointing that larger quantities are not forthcoming, but with the price of tin in this country fixed at £230 whilst about £50 more per ton is obtainable in outside markets, it must be expected that the tendency will be for metal to be sold abroad. Of course the market assumes that we can rely upon the Empire production being placed at the disposal of the British Government, but naturally neutral producers will endeavour to get the best price they can. A considerable quantity of tin has been exported from Great Britain, chiefly to the United States, and some consumers have complained that they have to work on a very narrow margin of supplies. No surprise, therefore, was expressed when the Board of Trade suspended export licences at present in force.

Lead and Spelter

There is little new to be said regarding the position in the lead market. Consumers appear to be obtaining all the metal they require and if there is any stringency it is apparently confined to certain brands and is not general. The consuming trades are working at a high rate of output, and large quantities of lead are passing into use. The necessity of maintaining secrecy regarding shipments reaching this country is causing irritation to the trade, although it is recognised that this is in the national interests. The Control seems to be working more smoothly. Buyers are finding it difficult to purchase lead ex ship, although the price for this delivery is scheduled in the Order, and have to pay the higher "ex warehouse" charge. A strong demand exists for spelter and considerable quantities are passing into consumption, but there is no scarcity and consumers seem to be getting their full requirements. It is possible that the position may become less comfortable later on since the official maximum home price is well below the figure obtainable in neutral countries and it is suggested that the Control may not be able to retain the quotation indefinitely at so much below the world price, notwithstanding that the Empire producers have patriotically agreed to sell their output at the official level. The latest Non-Ferrous Metals Order (No. 4) has made some alterations in the prices of zinc products. Zinc sulphide, lithopone, and zinc dust have been removed entirely from the schedule of prices, whilst the quotation for zinc sheets (No. 10 gauge and thicker) has been increased from £29 ex works to £30 12s. 6d. for lots of 5 tons and over. The price of rolled zinc (boiler plates) has been raised from £27 ex works to £28 12s. 6d., whilst hard spelter and dross have been altered from £11 5s. d/d buyers' premises to £11 ex works. The price of zinc oxide (Red Seal) has been advanced from £19 10s. d/d buyers' premises to £21.

New Iron and Steel Prices

The Ministry of Supply announced on November 1st a new range of prices for iron and steel materials. The latest schedule of maximum prices increases current quotations by 9s., to £1 7s. 6d. per ton. Pig iron is increased 9s., billets, joists, sections, and plates by £1. Re-rolled products have been raised by £1 4s. 0d. and sheets by £1 7s. 6d. It will be remembered that on January 1st prices were reduced by amounts ranging from 7s. 6d. to £1. Maximum prices have been imposed for home iron ore, cinder and scale, high speed steel, wire, forgings, steel castings, tyres, axles, solid wheels, and iron castings. In a note issued with the Order the British Iron and Steel Federation states that the industry decided to withhold an application for an advance in prices except to the extent that is consequential upon meeting from a central fund the additional costs that arise from importation of raw and semi-finished materials under war conditions.

French Engineering Notes

(From our own Correspondent in Paris)

Commercial Production

Two of the older classes in active service have been demobilised with the object of releasing men who are needed to carry on the work of producing what is necessary for the country's maintenance and trade. Practically all engineering works are employed either wholly or in part on orders for national defence, and they will remain busy all through the war, but experience of the last war showed that a country will suffer economically from an exclusive armament activity and must, therefore, do everything possible to keep up its home and export trade without sacrificing military requirements. Military mobilisation provides for the return of men engaged on essential work for national defence, and for the first time a mobilisation of labour was intended to make up for deficiencies in the supply of men for commercial production. This new organisation does not always provide the right sort of workers for particular industries. As activity is to be intensified in these and other industries more men are needed. The importance of being able to supply men to keep pace with an increasing output of manufactured goods has brought this industrial phase into closer touch with armament production, in the sense that the Minister of Armaments and the Minister of Labour are both arranging for a suitable distribution of labour that will allow of manufacturers carrying on their business while giving priority to labour requirements for national defence. As the labour mobilisation enables the State to exercise a monopoly of supply, and make a selection of men suitable for particular industries, there would be no difficulty in providing manufacturers with workers if there were enough skilled hands to draw upon. It is hoped that the demobilisation of the two classes that have nearly reached the military age limit will do something to make up for the present deficiency. Commercial industry was completely dislocated by the calling up of all men of military age, and it is now absolutely essential that work should be carried on as fully as possible, particularly as inducements are offered to manufacture for export by releasing such goods from the profit limitations imposed on manufactured products for home consumption. In view of what is being done for commercial industry there is every promise of its being restored gradually to normal activity.

Suction Gas Lorries

A new decree relating to road haulage makes it clear to hauliers that they cannot be certain of carrying on their business during the war unless they run their lorries and other vehicles on suction gas. Nothing is said about long distance haulage and the decree applies to public transport confined to one Department and only, in a few cases, to two adjoining Departments. The new regulation differs little from the preceding one, excepting that owners of public service vehicles running on petrol or gas oil are required to make fresh applications for licences. Hauliers employing suction gas vehicles are exempted from this formality and may continue to run over the routes indicated on their licence cards, while owners of lorries weighing less than 12 tons with load are authorised to carry on over their prescribed routes by making a simple declaration. This distinction is made on account of the rationing of petrol, which may eventually be insufficient for the requirements of public road haulage. With suction gas there is no restriction beyond what may be occasioned by irregularities in the supplies of fuel that may be remedied by a suitably organised distribution. A stage has been reached when suction gas is regarded as a necessity for road hauliers. Whereas previously a suction gas van or lorry was rarely seen outside certain regions, the number of such vehicles is now increasing. Their behaviour on the road is what would be expected from past experience. Lorries designed and newly built for running on suction gas are satisfactory so far as performance is concerned, but when light vans are transformed with suction gas equipments there are often difficulties, notably in keeping engines supplied with suitable gas under varying loads. Of the dozen or more makers of portable suction gas producers there are five or six whose names provide some guarantee of performance, and they are all busy dealing with the demand for equipments that, at present, offer the only assured means of carrying on road haulage services during the period of a possibly protracted war.

Machine Tools

With the object of utilising all machine tools available for armament production, and of distributing others where they can be used to the best advantage for commercial manufacture, measures have been taken to prepare a complete list of machine tools in works that are either closed or are engaged exclusively on commercial orders, as well as in works where machines are employed partly on commercial and partly on armament production. Machines marked as suitable for the manufacture of war material must not be removed. They are held until required by the armament services. The authority of commissions appointed to carry out this task of selection is not necessarily final, for the owner has the right of appeal if the machines are indispensable for his commercial manufacture, there being cases where the removal of one special machine has put entire plants out of action. An example of such serious dislocation occurred at one of the Schneider works when armament production was nationalised more than two years ago. On the other hand, the necessity for developing commercial production will doubtless carry weight with the armament services when the State is doing all it can to bring industry back to something like normal activity. This work of preparing a list of machine tools will certainly take a long time to complete. Meanwhile, another measure has been enforced, so far only in some districts, whereby selling agents are required to supply the Inspection des Forges with lists of all new and second-hand machines they have in stock, together with prices, and they are prohibited from selling machines without permission. French machine tool makers have long demanded such a national census as a means of enabling them to prepare production plans.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

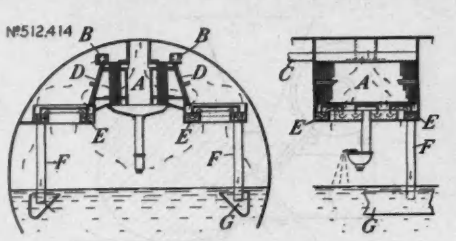
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS

512,414. *December 1st*, 1937.—Means for the Purification and Separation of Steam in Boilers, Foster Wheeler, Ltd., and Geoffrey Handley Hopewell, both of Aldwych House, Aldwych, London, W.C.2.

This invention relates to means for the purification and separation or drying of steam in steam boilers. Broadly, the object is to provide improved arrangements which enable the cleaning action of feed water to be utilised to better advantage. The cleaning means comprises a scrubber in the form of a bubble type washer fed with comparatively clean feed water through which the steam passes, and gutter baffles arranged in rows the

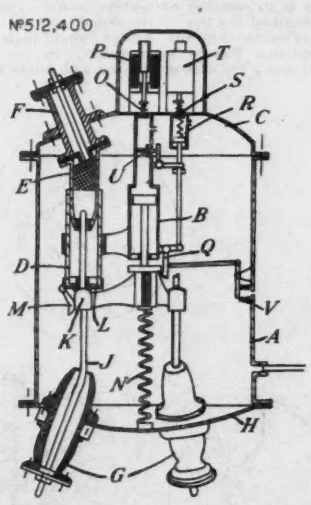


front rows of which are wet and separate solid particles from the scrubbed steam while the rear rows are comparatively dry and separate out the remaining particles of moisture from the steam. In the accompanying drawings is shown one arrangement in which a boiler contains a purifier unit A of the "Tracy" type fitted with two receivers B connected to feed water inlets C and surmounting rows D of gutter baffles the upper ends of which communicate with the receivers so that the feed water can flow down them. These baffles discharge into scrubber sections E communicating by pipes F with distributing troughs G, the steam bubbling through the water in the sections E before encountering the baffles.—*September 15th*, 1939.

SWITCHGEAR

512,400. *February 11th*, 1939.—Gas Blast Electric Switches, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

According to this invention, a gas blast circuit breaker having its operating mechanism and switching chambers enclosed in an outer container which also serves as a pressure gas reservoir is characterised in that the switching chambers corresponding to the three phases of the breaker are symmetrically disposed around a central operating cylinder having a piston connected to operate a bridge carrying the three movable contacts of the breaker. The drawing represents the construction of a three phase breaker without the partition only one phase being fully illustrated for the sake of simplicity. A indicates the container or casing of the breaker which also serves as a pressure gas reservoir. A pressure cylinder B equipped with a corresponding supporting frame is secured to the cover C of the casing. The switching chamber D, of insulating material, encloses at its upper end a metal tube E, which carries at its lower end the switch contact and at its upper end the current lead and an arrangement for cooling and silencing the switching gases. This tube is

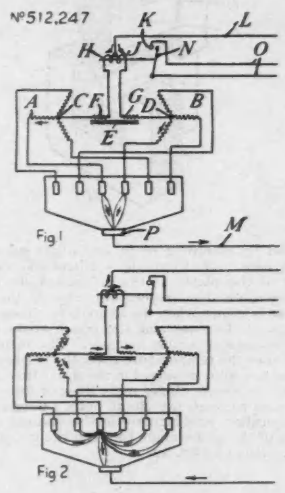


secured air-tight with its upper end to the leading-in insulator F mounted air-tightly in the cover C, but allows the switching gases a free passage through its interior into the open. The current supply is effected by means of the leading-in insulator G supported at the lower end H of the container. The current is supplied to the movable contacts through flexible conductors J. The movable contacts are arranged on a three-armed switch bridge K secured to the operating piston working in the cylinder B. In the closed position indicated, the switch bridge serves to close air-tightly the lower end of the switching chamber packings L being used if necessary. In the open position in which the switch bridge K is located below and the movable contacts project out of the sliding contact, the closing is effected by a flap M which with the upward movement of the contact is raised by the contact itself. The movement of the switch bridge K downwards is effected by the spring N. When the bridge K and the piston connected with it are in the lower position then by means of a small opening in the upper reduced part of the pressure cylinder, the result is obtained that the space above the piston is under the same pressure as the container, so that no resultant pressure is exerted on the piston. In order to effect the upward movement of the piston to effect closure of the breakers, the valve O arranged in the cover of the container is opened by a magnet P. The air above the piston then escapes to the outside, so that the excess pressure acting on the piston moves the latter upwardly and effects the upward closing movement of the contacts. It is held in this position by the pawl Q. If the breaker is to be opened, then this pawl is released by means of the pressure cylinder R in which upward movement of its piston is effected in the same manner as for the cylinder B when the valve S is opened by the magnet T. In order that the compressed air which is in the cylinder B above the main piston may not obstruct the opening movement by having its pressure reduced due to the movement of the piston, simultaneously with the lifting out of the pawl Q valve U is opened by the pressure cylinder R, whereby the space above the piston is brought into connection with the pressure container. The arrangement for the automatic opening of the breaker on the reduction of the pressure below a predetermined value is effected by means of a corrugated tube V whose inner space is in connection with the outer air, so that it expands and thereby causes the pawl Q to be released when the internal pressure drops.—*September 1st*, 1939.

TRANSFORMERS AND CONVERTERS

512,247. *March 2nd*, 1938.—Vapour Electric Arc Converter Arrangements, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Henry Horatio Taylour, of The General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

The converter arrangement shown comprises a six anode mercury arc rectifier and arranged to be supplied from a three phase alternating current circuit (not shown) through a transformer having six secondary phases arranged as two three phase star-connected groups A and B in phase opposition, the star points C and D of the two groups A and B being connected together by an interphase transformer E. The winding of the interphase transformer comprises two sections F and G, the adjacent terminals of which are connected together through the two sections H and J of the operating winding of a high speed differentially wound relay K and the remaining terminals of which sections F and G are connected to the star points C and D of the two groups A and B, the junction of the two sections H and J being connected with the negative lead L of the rectified direct current circuit. The positive lead M is connected with the cathode P of the rectifier. Contacts N are connected to a trip circuit O, and when the contacts N are operated the trip circuit O is energised to suppress a fault in the rectifier by means

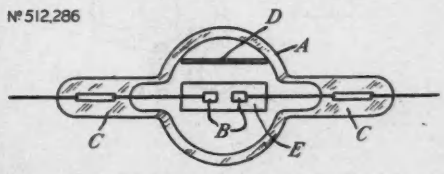


of blocking or quenching grids (not shown) and/or by operating circuit breakers (not shown) in the A.C. and D.C. circuits of the rectifier. Under normal conditions of operation of the rectifier, with the exception of a small magnetizing component, the direct currents in the two sections F and G of the interphase transformer and in the sections H and J of the relay operating winding are of the same magnitude, since anodes of the two groups A and B carry current simultaneously as indicated in Fig. 1 but are in opposite directions and the relay contacts N remain unoperated. However, upon the occurrence of back-fire or back-ignition conditions within the rectifier as indicated in Fig. 2 and the consequent unbalance of currents in the sections F and G of the interphase transformer E and in the sections H and J of the operating winding of the relay K, the contacts N of the relay K are operated to suppress the fault. Actually, under fault conditions, there is a resultant pulsating current through the interphase transformer E and the two sections H and J of the relay operating winding away from the group A (as indicated) including the anode at which the back-fire or back-ignition is taking place, and the relay K is set to operate its contacts N when the value of the current through the sections H and J of its operating winding exceeds the normal on-load magnetising current of the interphase transformer E by a predetermined amount.—*August 31st*, 1939.

ELECTRICAL APPLIANCES

512,286. *July 29th*, 1938.—High-Pressure Metal-Vapour Electric Discharge Devices, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and John Walter Ryde, of Research Laboratories of The General Electric Company, Ltd., Wembley, Middlesex.

This invention relates to high-pressure metal-vapour electric discharge (H.P.M.V.) devices of the type wherein, in full opera-



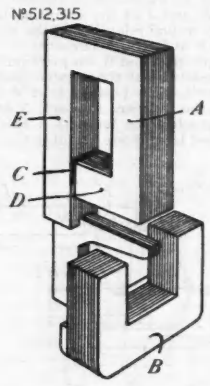
tion, the pressure of the vapour exceeds 5 atmospheres and the distance between the terminations of the discharge path is much less than any internal dimension of the envelope in a plane perpendicular to the straight line joining the terminations. It relates also to their manufacture. Devices of this type may burst in operation under abnormal conditions. It is easy to make the main part of the envelope strong enough to stand the internal pressure so long as it is in its original state, but convection currents playing on it are apt to devitrify or otherwise

weaken it. The object of this invention is to provide shields that can be introduced through narrow apertures in the envelope subsequently filled, for example, by the seals carrying the leading-in-conductors and that yet protect the envelope sufficiently. The envelope A of an H.P.M.V. lamp dissipating 500 watts in operation is a quartz sphere some 400 mm. in internal diameter and some 3 mm. thick. The electrodes B lie along a diameter and are spaced 5 mm. apart symmetrically about the centre. The apertures, finally closed by the seals C, carrying the main electrodes, were originally 8 mm. in diameter. Each shield D or E consists of a strip of quartz 8 × 25 × 1·5 mm., introduced through one of these apertures. A single strip of this kind is usually sufficient to protect the envelope from the convection streams in any one position of the lamp; but two end to end may sometimes be preferable. Strips D and E are in mutually perpendicular planes, so that the lamp can be operated in two positions differing in rotation through a right angle about a diameter of the envelope. The strips are fixed to the envelope at their corners by fusion.—*August* 31*st*, 1939.

MEASURING AND TESTING INSTRUMENTS

512,315. *April* 26*th*, 1939.—Temperature-Compensation of Ferraris Meters, Landis und Gyr A.-G., of Hofstrasse 1, Zug, Switzerland.

This invention relates to a Ferraris meter, wherein there is employed a thermally sensitive alloy for the compensation of the temperature error. In the accompanying drawing there is shown in perspective view by way of example one constructional form or embodiment of the invention applied to a pressure core of a meter driving system. The driving system of the Ferraris meter comprises a pressure core A and a current core B. A plate of thermally sensitive alloy C with a positive temperature coefficient is arranged in the air gap formed by the shunt limb D and the return yoke E. The plate of thermally sensitive alloy

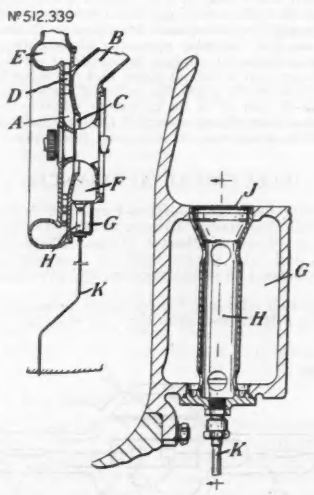


can be secured by clamping or in any other suitable manner to the pressure core. The thermally sensitive alloy can obviously replace some of the plates of the laminated shunt limb. In order to compensate the temperature error of the meter to a large extent, as is known when the temperature rises the pressure driving flux must decrease and the phase angle between the current and voltage fluxes must increase. This result is attained in that, as soon as the temperature rises, the permeability of the thermally sensitive alloy arranged in the shunt thereby becoming greater permits correspondingly more lines of force of the pressure flux to pass through the shunt path. Consequently with a rise of temperature any increase in the turning moment and any reduction of the phase angle between the two driving fluxes is prevented.—*August* 31*st*, 1939.

AERONAUTICS

512,339. *March* 31*st*, 1939.—Induction Systems of Internal-Combustion Engines, The Bristol Aeroplane Company, Ltd., Alfred Hubert Roy Fedden, and Leonard Frederick George Butler, all of Filton House, Bristol.

The supercharging blower for an internal-combustion engine comprises a centrifugal fan A driven from the crankshaft of the engine. The fan takes in a mixture of fuel and air through a branch B from a downdraught carburettor, the branch leading into the eye C. The mixture is discharged through the diffuser D into a collecting chamber E from which it flows through induction pipes to the engine cylinders. The branch B leads into a scroll-shaped intake chamber F from which the

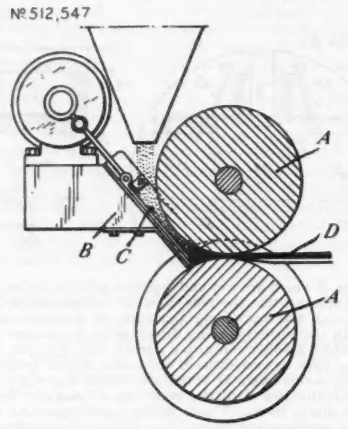


eye is fed. The bottom of the chamber is formed with a sump G. The intake chamber communicates with the sump through a hole to which is fitted the upper end of a tube H which is perforated as shown. The bottom end of the tube is formed with a cap which closes a hole in the bottom wall of the sump. At its top end the tube is flared outwardly, and receives a flame-trap J consisting of a fine gauze or grid of metal having a high heat-conductivity. At its bottom end the tube is connected by a coupling to a pipe K of comparatively fine bore which leads to a point beneath the surface of a structural part of the aircraft wing or fuselage. When the engine is running, any fuel which condenses in the intake chamber runs down through the gauze into the tube; from the interior of the tube it can flow through the perforations into the surrounding space within the sump. The pressure in the intake chamber is lower than atmospheric pressure so that air is sucked through the pipe K, and passes through the fuel which is thus vaporised, the vapour passing up through the flame-trap into the intake chamber and from thence into the engine cylinders. The pipe is of such small bore that the flow of air through it is negligible compared with the flow of mixture from the carburettor along the branch. If a back-fire should occur, the flame is arrested by the gauze before it reaches the level of the fuel in the sump. When the engine is stopped, any fuel remaining in the sump drains away to waste through the pipe.—*September* 1*st*, 1939.

BUILDING

512,547. *November* 21*st*, 1938.—Machines for Making Tiles, G. H. Downing and Co., Ltd., Audley Road, Chesterton, Stafford, and James Edwin Marsden, Blurton Tileries, near Longton, Stafford.

This invention relates to machines for making tiles or the like, and is intended to provide improved means for increasing the density of the clay. The machine comprises a pair of superposed expression rolls A, a feed table B at one side of the rolls, a power operated reciprocating slide C on the table for forcing the material into the space between the rolls, and a hopper above

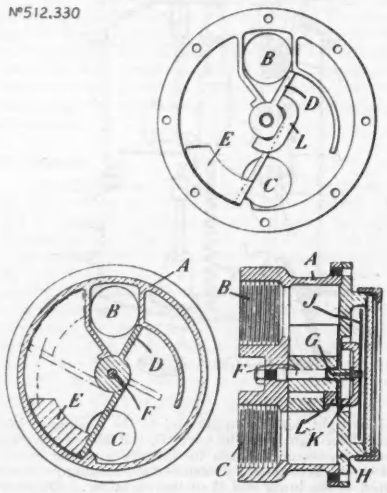


the table having its delivery opening over the table so as to drop a stream of material on the table between the positions occupied by the forward end of the slide at the two ends of its stroke. The slide may be provided with a ram end, and a tapering part leading to the ram end, so that on the return stroke the slide can pass beneath the clay and the clay can slip over the slide and tapering part so as to pass to the front of the ram. The ram has the effect of forcing the clay into the space between the rolls and imparts increased density to the ribbon of clay delivered to the making table D on the delivery side of the rolls.—*September* 19*th*, 1939.

MISCELLANEOUS

512,330. *March* 11*th*, 1938.—Liquid Flow Indicator, The Light Production Company, Ltd., and Percival John Hutchings, both of 60/66, Rochester Row, Westminster, London, S.W.1.

The flow indicator has a body A provided with inlet and outlet connections B, C. Within the body is pivotally mounted a vane D which is spring- or gravity-controlled (as, for example, by the weight E) so that normally it separates the inlet from the outlet. When, however, liquid is flowing in the system the vane is moved so as to establish connection between the inlet and outlet to permit of the flow of the liquid, and the movement of the vane is indicated by any suitable form of visual indicator which is operated thereby magnetically. In the particular construction shown the vane is provided with a boss adapted to



pivot on the spindle F secured to the body and at one end of the boss is a recess in which may be mounted a projection G from a cover H. The outer face of the cover is formed with a flange constituting a recess in which is mounted a disc J having a magnet K secured thereon and co-operating with a magnet L carried by the movable vane so that the disc will move with the vane. The disc is associated with a suitable cover plate having apertures therein through which distinctive markings upon the disc will be visible when the vane is in position to allow of the flow of the liquid. The arrangement is such that when no liquid is flowing, for example, the disc will show black through the apertures in the cover plate but when liquid is flowing white or other distinctive markings upon the disc will appear in the apertures of the cover plate.—*September* 1*st*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Civil Engineers

Saturday, Nov. 4th.—Yorkshire Assoc. Hotel Metropole, Leeds. "The Engineer—Technically, Commercially and Personally," J. Taylor Thompson. 2.30 p.m.

Tuesday, Nov. 7th.—Great George Street, Westminster, S.W.1. Ordinary meeting for reading the names of candidates for election passed by the Council for ballot. 3 p.m.

Tuesday, Nov. 21st.—Great George Street, Westminster, S.W.1. Ordinary meeting for the election of new members. 3 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, November 21st.—39, Elmbank Crescent, Glasgow. "Characteristics of Silent Propellers," A. W. Davis. 6.30 p.m.

Iron and Steel Institute

Thursday, Nov. 23rd.—4, Grosvenor Gardens, S.W.1. Statutory Autumn Meeting. 3.30 p.m.

Newcomen Society

Wednesday, Nov. 8th.—Chartered Institute of Patent Agents, Staple Inn Buildings, High Holborn, W.C.1. Annual General Meeting. "Newcomen and the Ironmonger's Trade in His Day," W. A. Young, and "Dud Dudley's Mettalum Martis Re-examined," T. E. Lones. 2 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Friday, Nov. 10th.—Mining Institute, Newcastle-upon-Tyne. "Welding as an Integral Part of Design," B. P. Haigh. 5.30 p.m.

Royal Institution of Great Britain

Wednesday, Nov. 8th.—21, Albemarle Street, W.1. "Thermodynamics and the Structure of Matter," A. R. Ubbelohde. 2.30 p.m.

Thursday, Nov. 9th.—21, Albemarle Street, W.1. "Modern Radio Apparatus," C. L. Fortescue. 5.15 p.m.

Friday, Nov. 10th.—21, Albemarle Street, W.1. "Infra-Red Spectra and the Structure of Molecules," W. H. J. Childs and H. A. Jahn. 2.30 p.m.

CONTRACTS AND ORDERS

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The English Electric Company has received from the Crown Agents for the Colonies an order for eight Diesel-electric rail cars for the Ceylon Government Railways. The power equipment will consist of an "English Electric" engine developing 180/200 H.P. at 1350 r.p.m., and "English Electric" electrical transmission. Each car will seat 78 passengers and will be of welded steel construction. The complete vehicles are being build in the works of The English Electric Company, Ltd.

John I. Thornycroft and Co., Ltd., Smith Square, London, S.W.1, have received orders for marine engines for installations abroad. In Peru a tug is under construction which will be powered by a four-cylinder, 36/47 B.H.P. oil engine unit. A launch to be put into service at a timber plantation in Belize, British Honduras, will have a "Handybilly" 9 B.H.P. petrol unit. A six-cylinder 70 B.H.P. oil engine and a Thornycroft converted Ford V/8 engine are destined for Brazil. Two six-cylinder oil engines, each of 145 B.H.P., will shortly be despatched to Singapore for installation in a fast launch now under construction.

PERSONAL AND BUSINESS ANNOUNCEMENTS

The Steel Barrel Company, Ltd., Uxbridge, advises us that Mr. William Lawson Lithgow has resigned his Directorship with the Company and its associated companies, to take up an important position in connection with the War.

The Brooke Tool Manufacturing Company, Ltd., informs us that Captain Allan Kyle, Mr. Hyla Stone Holden (appointed Managing Director), and Mr. Bertie Sharp (appointed Works Director), have joined the Board of Directors of the Company. Mr. Stanley Charles Icke has resigned from the Board.

Mr. T. P. N. Burness, M.I. Mech. E., M.I.P.E., who was recently appointed Managing Director of William Asquith, Limited, Halifax, following the resignation of Mr. J. L. Munn, has now taken up his duties with that company. Mr. Burness is a native of Motherwell, Scotland, where he received his early engineering training, and was Works Director of Ruston and Hornsby, Limited, Lincoln, with which firm he was associated for 23 years.

Head, Wrightson and Co., Ltd., Thornaby-on-Tees, announce that their London and Birmingham offices are carrying on, although skeleton staffs are retained. In the event of an extreme emergency, arrangements have been made for the London Office to be transferred to 47, The Green, Richmond, Surrey, and the Birmingham Office to 12, Stoner Road, Hall Green, Birmingham. The London Office is still in constant communication with the Works at Thornaby-on-Tees, through the Teleprinter Service.

CATALOGUES

Cambridge Instrument Co., Ltd., 13, Grosvenor Place, London, S.W.1.—List No. 150A, containing full particulars of automatic electrical, mechanical thermometers, hydrostatic and pneumatic regulators.

B.E.N. Patents, Ltd., High Wycombe, Bucks.—"Painting by Modern Methods," a pamphlet illustrating and describing paint-spraying plant and equipment.

Herbert Morris, Ltd., Loughborough.—Book 197 on the construction and uses of petrol-electric or oil-electric runabout cranes with capacities from 12 cwt. to 1½ tons.

Paterson Engineering Co., Ltd., Windsor House, Kingsway, W.C.2.—Publication 445 dealing with chlorine treatment of sewage and trade effluents and condenser cooling water.